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Do You Know What Is In Your Junk Pile?

If Not—Here's a Good Scheme You Can Use to Find Out and the Sorting Will Pay in the Better Rates for the Junk

THESE two photographs present a study in junk values. In most plants junk is just junk and when sold its value is based upon what appears to be the bulk of the material in the pile. In a New England plant where these pictures were taken, however, someone has found out that it's about as easy to sort junk materials while they are being accumulated as it is to dump everything together in one large pile. Besides, his idea has shown a nice profit for the maximum junk value is obtained for the different materials and the box scheme makes handling and weighing a very easy matter.

While visiting with the works engineer of another large plant a little while ago he told me that a lot of materials heretofore sold at junk values were now being refined and sold as metal of a definite composition. This expenditure in refining has shown a handsome profit.

We referred several months ago to an automobile plant where the maintenance engineer had found that his junk pile was worth about $500,000 a year through studying how junk is handled as a commercial product first from dealer to the yard, yard to the junk broker and broker to the junk user. This value was obtained by sorting junk material into the grades that are in demand.

Waste in the form of scrap ends, and miscellaneous this and that, may be unavoidable in connection with certain kinds of manufacturing but it may also represent carelessness and indifference on the part of someone. Any plan of handling junk materials and keeping track of their kind and value besides being a profitable way of disposing of it, can also be used to check up the source of this waste and the rate at which it accumulates. On the basis that hindsight is often more keen than foresight an accurate record of production wastes sold as junk can be used to avoid repetition of poor guesses that sometimes sneak into the making up of a raw material schedule in a large works.

Since this is good resolution time for a new year this plan of getting maximum value for the junk pile is a good one to add to a revision of last year's list.

Practical Pete

Activities of the

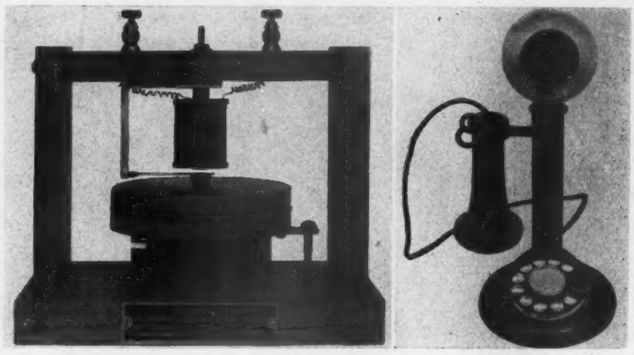
American Telephone and Telegraph Company

And Its Manufacturing Organization, the

Western Electric Company

Any two of the 15,000,000 telephones in the United States can be connected for conversation. The thirteenth of a series devoted to the growth and extent of our basic American industries.

COMPARE these pictures: 1875, two crude instruments on which words were with difficulty transmitted from one room to the next; 1923, almost 15,000,000 telephones, any one of which may be connected with any other even though the two be separated by the width of this country. This comparison will give some idea of the development of the system of the American Telephone and Telegraph Company.



Bell's first instrument and a modern dial desk 'phone.

The telephone of Alexander Graham Bell in 1875 consisted of an electromagnet before which was suspended a strip of iron attached to a vellum diaphragm. The vibrations of the diaphragm caused corresponding changes in the current, supplied by a battery, flowing through the coil. The dialing 'phone is used in connection with automatic machine switching telephone systems which make the connection automatically.

This company was formed in 1885 by the American Bell Telephone Company for the purpose of building and operating long distance lines to interconnect the companies, licensed under Bell patents, that were giving local service where before 1875 business was transacted largely by messenger boys instead of the almost instantaneous telephone connection. For fourteen years it was distinctly the telephone company of long lines. Then it succeeded the American Bell Telephone Company as the central company of the federation that has become the Bell System. Besides owning and operating the physical plant that unites the associated companies into one system, it handles all national problems affecting it, protects all patents, and is the headquarters of invention, information, capital, and legal protection for the entire federation of Bell companies. Only by such a federation, whereby each local company must use standard equipment and standard methods, could satisfactory, long-distance communication be possible. Realizing this, the parent company early undertook the search for improvements in the telephone art, and the supervision of the development of scientific discovery and

The Hawthorne (Chicago, Ill.) plant of the Western Electric Company.

Practically all the telephones, switchboards, cables and other equipment used by the American Telephone and Telegraph Company in all their systems in the United States, are made by the Western Electric Company. This Chicago plant covers 200 acres, consists of 102 buildings containing 4½ million feet of floor space and employs 38,000 workers. It is estimated that it requires a week for a man to casually walk through the various aisles and departments and give even a superficial glance at all the operations performed. The group of buildings at the left of the railroad track, through the center of the plant, is devoted to the manufacture of cable and enameled wire. The largest telephone cables manufactured contain 1,200 pairs of wires, insulated and enclosed in a heavy lead sheath. One-eighth of the lead produced in the world is used for this purpose. About 85,000 tons of copper, lead and insulating paper are used annually for making lead-covered telephone cable alone.

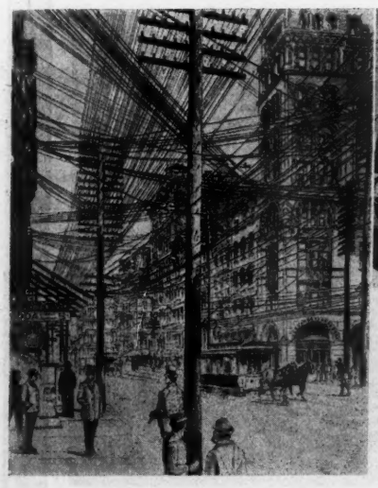
Only one-fifth of the 1,900 telephone buildings owned by the Bell System.
Almost two-thirds of all the telephones in the world are in this system. The operation of this requires over 250,000 employees. The 6,000 exchanges handle about 42,000,000 telephone calls every day. Of the 15,000,000 telephones in the United States, any one may be connected with any other even though they may be separated by the continent.

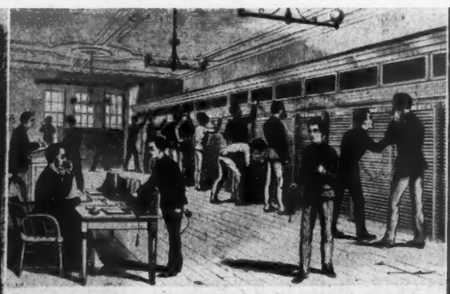
the manufacture of telephone apparatus and equipment.

The result today of all this coordinated activity is an American telephone system that interconnects nearly two-thirds of all the telephones in the world, has over 250,000 employees, has 6,000 exchanges that handle 42,000,000 telephone conversations every day, and owns physical assets costing over $1,900,000,000. All this has grown from the two-man concern of Alexander Graham Bell and Thomas A. Watson in 1876.

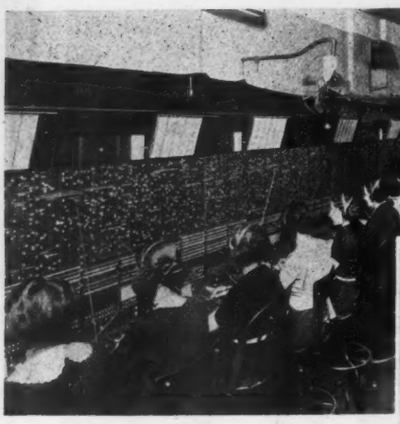
The growth of the Bell System called for coincident growth of manufacturing facilities. Until 1878 all Bell telephone apparatus was made by Watson in Charles Williams' little shop in Boston, a building long since transformed into a theatre. But the business soon grew too big for the shop. Four manufacturers of electrical apparatus, one of which was the Western Electric Company, were then given licenses to make telephone instruments and apparatus. Due to lack of uniformity the factories were combined and their product standardized.

In 1881, the manufacturing companies were merged under the name of the Western Electric Company which became, as it is today, the manufacturing unit

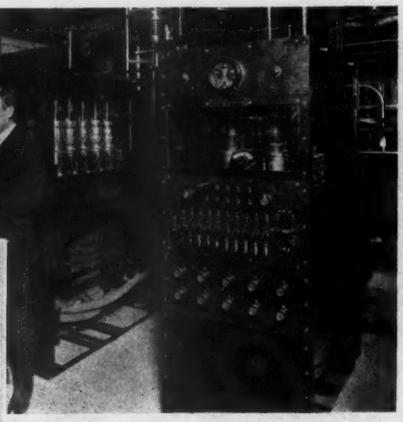




Early developments of the industry.
The two outside photographs show the corner of Broadway and John streets, New York City, in 1880 and in 1916 respectively. The American Telephone and Telegraph Company building, 195 Broadway, at the left, contains the general offices. The first switchboard in 1880 at the Cortlandt Exchange, New York City, was operated by boys.



A modern telephone switchboard.
Telephone messages are usually handled by two operators; the first receives the signal of the subscriber on what is known as the "A" board and signals to another operator on a "B" board who "plugs in" and rings the party called. In machine switching exchanges the connections and disconnections are made without the assistance of central operators.

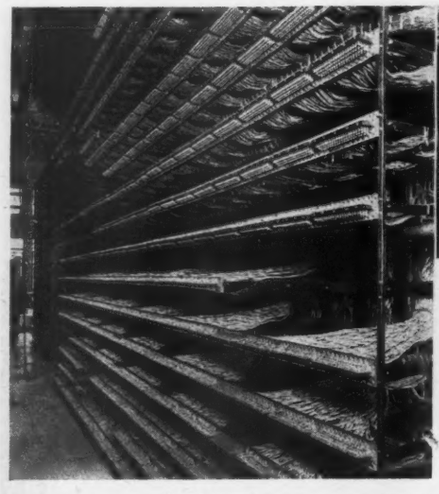


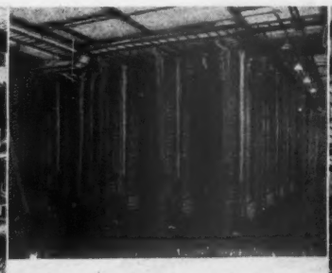
Radio broadcasting station, WEAF.
The antennas of WEAF, the experimental broadcasting station of the American Telephone and Telegraph Company, is located on the Walker Street Building (at the left) in New York City, in which all the long distance telephone lines entering New York terminate. The view above shows the vacuum tube installation used in sending the voice across the Atlantic on January 14, 1923.

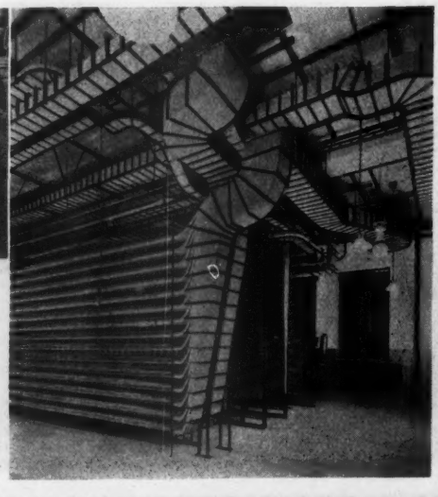
of the Bell System. This company is the largest of its kind in the world. At its great plant, consisting of 102 buildings covering 200 acres and containing over 84 acres of floor space at Hawthorne, Chicago, Ill., over 38,000 workers are engaged in transforming raw materials, brought from all parts of the world, into telephone apparatus in hundreds of different forms. Each year over 4,000,000 miles of wire are built into cables, enough to make 15,000 wires between New York and San Francisco. About 3,500 telephone sets are turned out daily in contrast to about 25 per day a score of years ago.

No other single company uses as much copper wire, hard rubber, or hard brass. A thousand pounds of platinum a year are used in the manufacture of contact points for telephone desk sets alone. Silk thread from Japan, paper tape from Manila, mahogany from South America, rubber from Brazil and the Congo, cotton from Egypt, linen from Mexico and Ireland, iron from Norway and Sweden, platinum from Russia and Colombia, shellac from India, tin from the Dutch East Indies, shows the diversity of raw materials used.

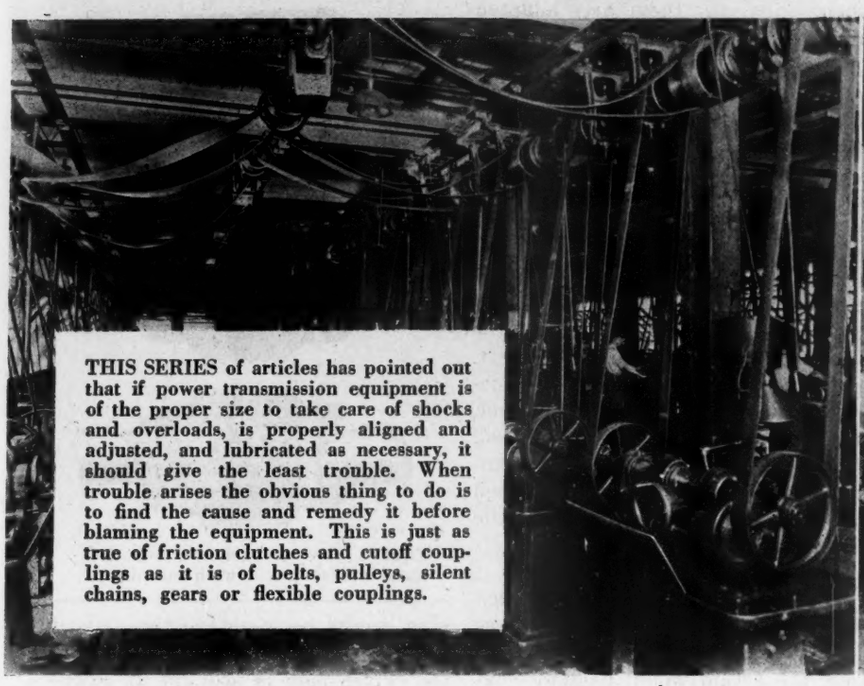
Another function of the American Telephone and Telegraph Company, which has made possible the wonderful telephone art of today, is that of development and research. The large engineering and scientific staff engaged in this work examines and studies all new patents relating to the telephone and telegraph issued in various countries, and considers all the latest discoveries in pure and applied science including problems of wire and radio transmission.



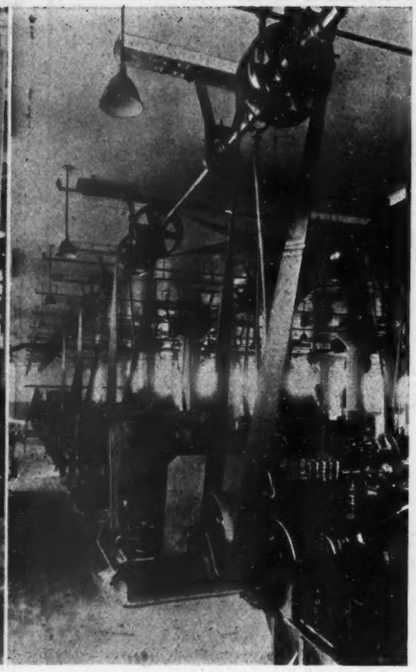




Three views in a telephone exchange.
One of the switchrooms in the machine-switching CENtral Exchange in Chicago (above). The other views show small parts of "distributing frames" of two telephone exchanges, each containing miles of wire and thousands of soldered joints.



THIS SERIES of articles has pointed out that if power transmission equipment is of the proper size to take care of shocks and overloads, is properly aligned and adjusted, and lubricated as necessary, it should give the least trouble. When trouble arises the obvious thing to do is to find the cause and remedy it before blaming the equipment. This is just as true of friction clutches and cutoff couplings as it is of belts, pulleys, silent chains, gears or flexible couplings.



By driving this battery of machines from friction clutch pulleys on lineshafts, as above, it is not necessary to install the mass of belts and countershafts shown in the illustration at the left. Also, any machine or group of machines may be thrown out of action by clutches without having to throw off the belts.

Construction Details and Conditions Permitting

Use of Clutches and Cutoff Couplings

In Order to Reduce the Power Used by Idle Machines and by Shafting

By FRANK E. GOODING

Associate Editor, Industrial Engineer

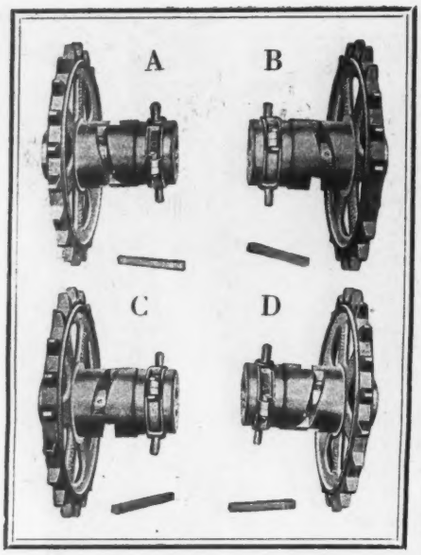
COUPLINGS, either of rigid, compression or flexible types, as have been described in articles in the October, November and December, 1923, issues of INDUSTRIAL ENGINEER, are used where the connection between sections of shafting or machines is permanent. These, however, usually may be disconnected when necessary by removing connecting bolts or pins or by dis-assembling. This is satisfactory for making repairs but is not often adaptable to operating conditions as it interferes with production.

On lineshafts, when it is desired to cut off a section temporarily at infrequent periods or for some time, spacing rings are sometimes used between the halves of flange couplings. By removing the connecting bolts, the spacing ring drops out and leaves sufficient clearance for one flange to rotate without interference with or rubbing on the other. The disadvantage of this method of connecting sections of shafting is that the driving shaft must be stopped for a few minutes either to connect or disconnect. For this reason, a section is seldom disconnected unless it is to remain idle for some time.

With friction or magnetic clutches so easily operated, there is no excuse for allowing a machine or group of machines to operate if they are to be idle for even a short period of time. This is not always taken advantage of when the disconnection is more difficult to make. Both types of clutches are also used advantageously particularly in connection with some types of synchronous motors, since these motors do not start well under load. By the use of a clutch the motor may be started light and the load applied gradually. This gives the same effect as a rheostat starting switch with a direct-current motor. Clutches are an important safety element in many machines in that in case of accident either to the operator or to the machine, tripping of the clutch will instantly disconnect and stop the machine instead of having to wait to stop the driving motor or engine or shift a belt.

Friction cutoff couplings, clutches and quills enable a section of shafting on a machine to be connected or disconnected almost instantaneously at will by a lever.

A friction cutoff coupling is ordinarily used to connect and cut off two sections of shafting. One-half of the coupling is usually keyed solidly to one shaft while the other half is keyed either solid or by a feather key to the other shaft. By different mechanical devices such as a lever, toggles, springs, spiral gears and other devices, one-half of the coupling is made to seize and clamp the other half. The friction clamping devices of clutches and cutoff couplings are quite similar in several types, particularly when a concern manufactures both cutoff couplings and clutches. In several such types

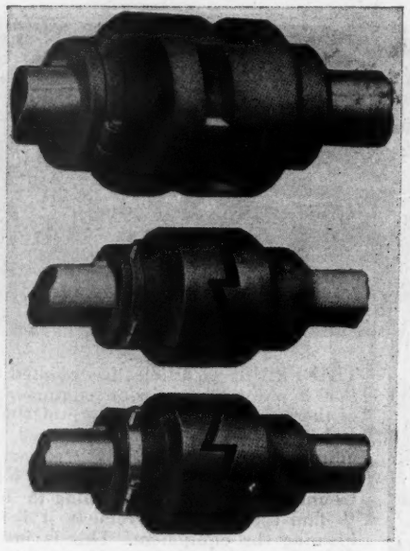


How to tell whether a spiral coupling is right-hand or left-hand.

A is a right-hand spiral coupling when the wheel drives and the direction of the motion is down, or when the shaft drives and the direction of motion is up. *B* is right-hand when the shaft drives and the direction of the motion is down, or when the wheel drives and the direction of motion is up. *C* is left-hand when the wheel drives and the direction of motion is up, or when the shaft drives and the direction of motion is down. *D* is left-hand when the shaft drives and the direction of motion is up or when the wheel drives and the direction of motion is down. A simple rule is: A clutch is right-hand if you can encircle the driving part of the clutch with the fingers of the right-hand pointing in the direction of rotation and have the thumb point toward the jaws of the clutch and act as a jaw. Conversely, a clutch is left-hand if you encircle the driving part of the clutch with fingers of the left hand pointing in the direction of rotation and have the thumb point toward the jaws of the clutch and act as a jaw. The application of this rule will be easily seen after trying it out on some of the clutches pictured here. A spiral clutch will drive in only one direction.

half the clutch is keyed on the shaft and the other half fastened to a loose pulley or gear which may ride on the shaft or ride on a special sleeve or extended hub. Clamping action is usually made by a lever. In reality, cutoff couplings and clutches differ but little in principles of construction other than is made necessary by the different uses.

Two of the first type of clutch or cut-off couplings designed were what are known as square-jaw and spiral-jaw crab clutches or couplings, as shown above at the right. These are also called claw or tooth clutch couplings and are usually engaged and disengaged by a lever. As either type must take the full load shock when engaged, they are adapted only to slow-speed operation where there is no objection to starting suddenly and the driving mechanism or shaft does not offer heavy load or much inertia. Square-jaw clutch couplings can drive in either direction and so can be used under reversing load. Spiral-jaw clutch couplings can be used only for driving in one direction and are designated either right- or left-hand as explained in connection with the four small illustrations at the left. One-half of this coupling is sometimes cast as the hub of a sprocket, gear or pulley, if such is used. Although these are seldom recommended for operation at a speed higher than 50 r.p.m., they have the advantage that they are always self-centering when in operation.



Square jaw and right- and left-hand spiral jaw clutch couplings.

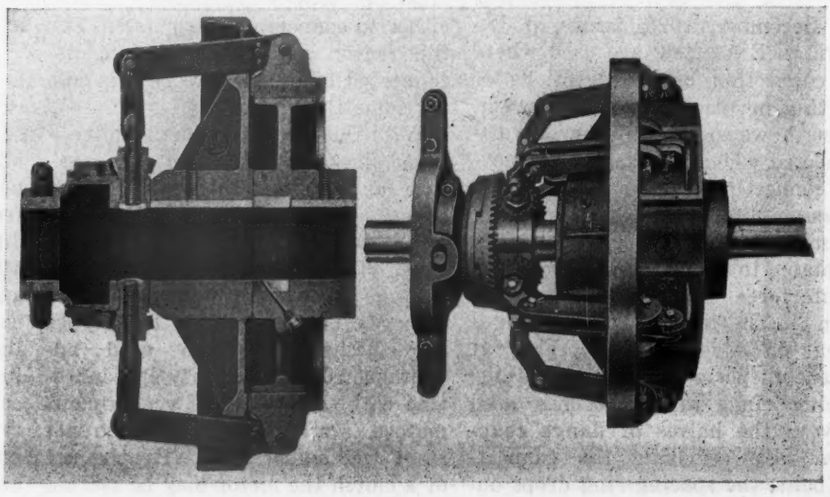
Modern industry demands a much higher speed than 50 r.p.m. If these older types of couplings were still used, the action would be somewhat like trying to start a train by getting the engine up to full speed and letting it bump the train to get it into motion. Since the result would probably be almost as disastrous in industry, other types of couplings have been found necessary.

With the increased speed of modern industry, these types of jaw clutches could not stand the severe service at the moment of starting up and so it practically became necessary to devise a type of clutch and cutoff coupling which could. In a friction clutch, or coupling, as its name implies, the friction of surfaces connected to the driving shaft with corresponding surfaces connected to the driven parts, cause the transmission of the rotating motion. When these friction surfaces are thrown into engagement one with the other, a certain amount of slipping occurs between the two sets of friction surfaces until the speed of the driven part is brought up to the speed of the driving part. After that, if the clutch is in proper adjustment no more slipping takes place because the friction is adequate to continue the drive. In addition to friction clutches, types of magnetic clutches are also used. One of these will be described later in the article.

Some Types of Friction Clutches and Cutoff Couplings

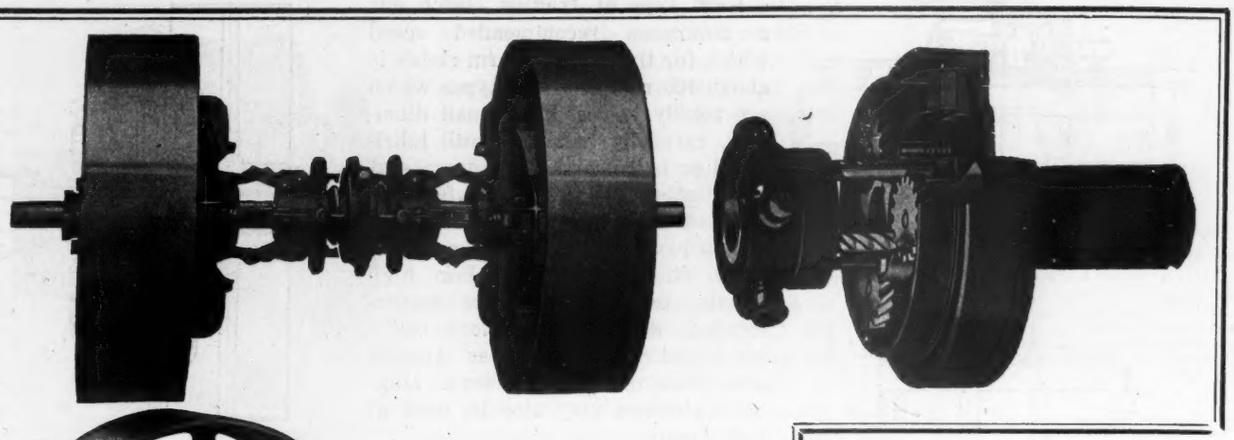
Friction clutches and cutoff couplings may be divided into three general classifications—cone, disk, and ring—according to the shape of the friction parts or clamping devices.

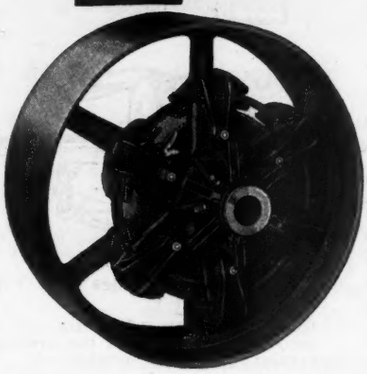
In conical friction clutches or couplings, one-half of the clutch, which consists of a frustrum of a cone, fits into the other half, which consists of a corresponding cone-shaped ring. In cutoff couplings the



One type of cutoff coupling and clutch.

Here wooden friction blocks are applied to a ring friction surface. One of the big advantages claimed for this friction clutch is the ease with which it may be adjusted evenly, to compensate for wear, by the bevel gear which adjusts all arms together.





Two applications of a ring-type friction clutch and a special type of disk clutch.

The double-throw countershaft, above, and the pulley clutch at the left, are six-arm ring friction clutches which clamp the cast-iron rings with special friction clamps on each side of the ring. The clutch above at the right is engaged and disengaged through a spiral gear which it is claimed allows the clutch to be operated at high speed with a positive gripping action. This clutch is totally enclosed and contains its lubricant. The pulley or gear is carried on the sleeve at the right.

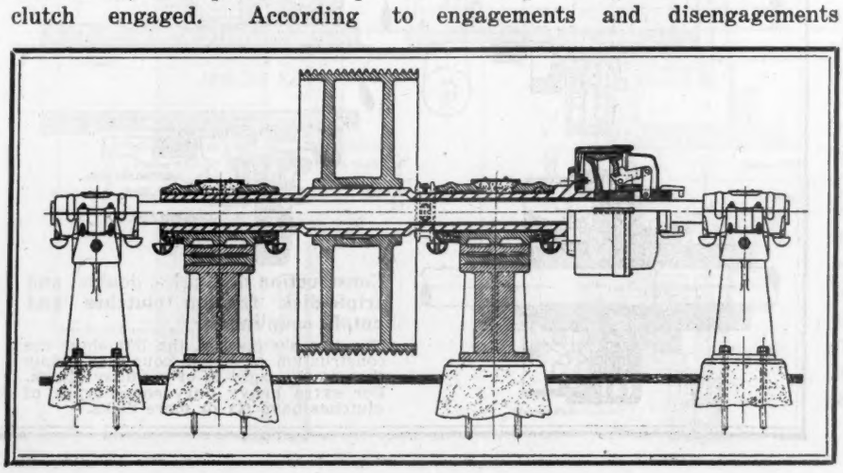
ring is keyed tight to the driving shaft, while the other half with the frustrum of the cone slides on the other shaft with a feather or sliding key. The two halves are engaged by a lever. When this is used as a clutch the ring is usually a part of a loose pulley which is held in place by a collar. Because of the end thrust developed by a single cone this use is generally not so satisfactory. End thrust is one of the chief objections to the single-cone type of clutch or coupling. Another difficulty lies in obtaining the proper slope of the cone; if too flat the jaws may stick and not disengage, while if made with too great an angle it is likely to take hold too suddenly. Also, more pressure (and end thrust) is required to keep the clutch engaged. According to Kent's "Mechanical Engineer's Handbook" this angle usually varies from 7½ deg. to 13 deg. from the horizontal. Single cone clutches are more often used in automotive work than for industrial purposes. These objections, however, are overcome by the double cone-friction clutch illustrated on page 8. The two conical friction surfaces are at a different angle and overcome the above objections.

The friction surface, as on all types of friction clutches and cutoff couplings, may consist of cast iron to cast iron, or cast iron to asbestos, leather, wood block (usually end grain of hard maple), cork insert and special compositions of various manufacturers. The material to be used depends upon the service. If engagements and disengagements are frequent a material must be used which will not overheat easily and stick.

Friction disk cutoff couplings or clutches, as may be seen from the group of illustrations on page 8, apply pressure on both sides of one or more disks or in opposite directions on two or more disks and so eliminate end thrust. The construction of the various types is given in connection with the illustrations and so is not repeated here. With the double application of pressure the action is positive when either engaging or disengaging. Most of these clutches and cutoff couplings, as will be noticed, apply the pressure through a toggle. In some of these it will be noticed that a spring is used to force apart the clamping jaws so as to make a positive disengagement.

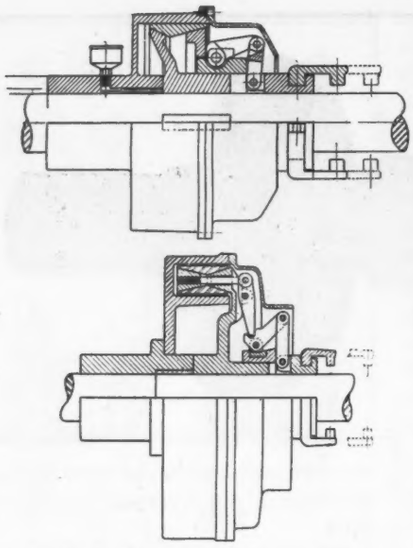
In ring couplings, several types of which are illustrated in this article, clamping action may be applied on the outside or inside of the ring or sometimes on both sides. Also, as in some disk couplings, a V-block clamp fits into a V-ring. This gives a greater friction surface with a narrower ring. The various types of rings, friction clutches and cutoff couplings will also be discussed in connection with the illustrations and so are not repeated here.

In addition to the clamping action several other types of friction couplings and clutches have expanding rings. The expansion is produced



This sketch shows the construction of a quill drive.

When a large pulley or sheave is used on a shaft, it is often mounted on a hollow shaft called a "quill," which is supported on its own bearings. The clutch connects and disconnects the quill. There is no connection between the quill and the shaft except through the clutch. In this way, an entire section of machinery or equipment can be thrown out temporarily or until the driver gets up to speed. The quill may carry either the driver or driven pulley or sheave.



A single- and a double-cone ring-type friction clutch and cutoff coupling.

In this type of clutch, the cone friction surfaces are at two different angles—one steep and the other flatter—which obviates the possibility of sudden seizing or sticking.

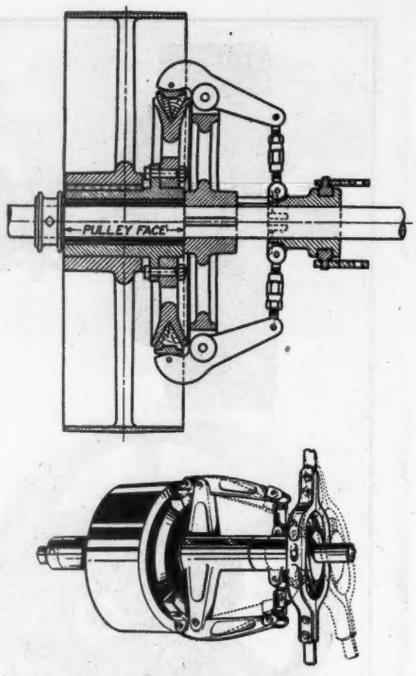
by wedges or dogs, or other various twisting or expansion devices. Friction hub clutches are often used on countershafts.

Countershafts with tight or loose pulleys usually have some form of clutch which may be thrown in and out by the machine operator. Many manufacturers are making the loose pulley and clutch together, as will be noticed from some of the illustrations in this article. Where both forward and reverse operations are required, as on a lathe, these are put in pairs, as shown on page 7.

It is becoming quite common practice to eliminate countershafts entirely on machines with only one driving belt and place clutch pulleys on parallel lineshafts driving down to the row of machines. This not only connects the machines more closely to the driving unit but also reduces the amount of belting required and eliminates countershafts which amounts to a big item in installation and maintenance costs. On the other hand, more lineshaft is required. An interesting pair of illustrations at the head of this article show the difference in appearance and amount of overhead equipment required to be installed and maintained in the two installations. The smaller amount of equipment also means a corresponding decrease in installation cost and in the opportunity for friction, slippage, hot bearings and other power transmission losses.

Each type of friction clutch has a maximum recommended speed which for the ordinary arm clutch is about 400 r.p.m. Other types which are totally enclosed, of small diameter, carefully balanced, well lubricated or ball bearing can operate at high speeds. One manufacturer claims that his equipment will operate up to a circumferential speed of 5,000 ft. per minute. For high speeds, ball bearings are recommended, as they are more easily lubricated and give less trouble from sticking or tight pulleys. Magnetic clutches may also be used at high speeds.

Where the size or weight of a pulley, sheave, gear, or rotor in connection with a friction or jaw clutch is so large as to make it impracticable to mount it on a sleeve, because of insufficient bearing capacity, a quill is often used. A quill, as shown in the illustration on page 7, is a hollow shaft supported by independent bearings. The main driving shaft running through the quill is thus relieved of all transverse stresses, such as the pull of belt or rope and also the weight of the pulley or sheave. The power is transmitted to the quill by means of a friction or a jaw clutch. When the clutch is disengaged and the quill standing still it does not wear as the revolving shaft does not come in contact with the quill at any point. On the other hand, if the quill is revolving with the clutch thrown out and the inner shaft idle, the only wear is in the quill bearing. Jaw clutches are frequently used but only if the speed is low or conditions are such that they can always



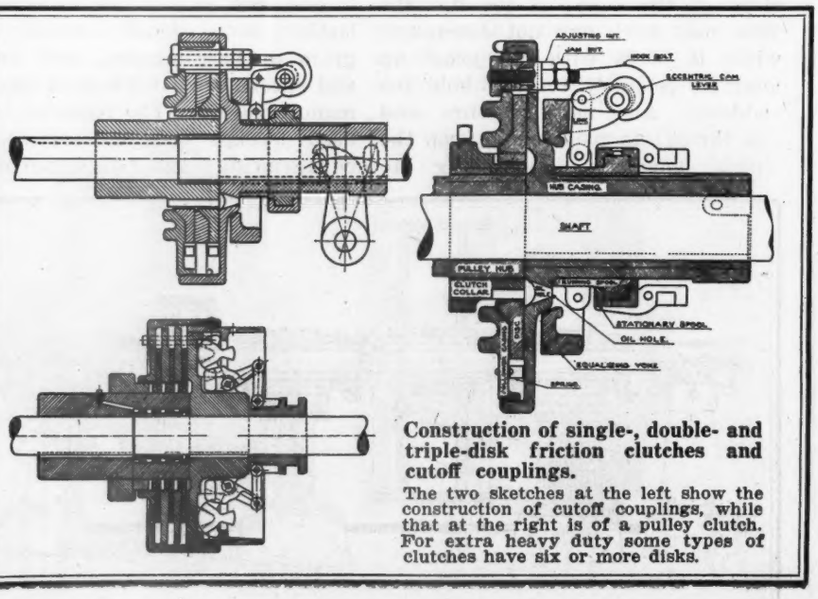
Two types of clutches with V-friction rings.

Here the friction block fits into a V-groove. In both cases the pressure is applied by a toggle motion.

be engaged or disengaged when at rest. Frequently quills are used to connect the driver to the shaft as then the driver can be started up with the clutch out and carrying no load except the slight bearing load of the quill until up to speed when the clutch is thrown in.

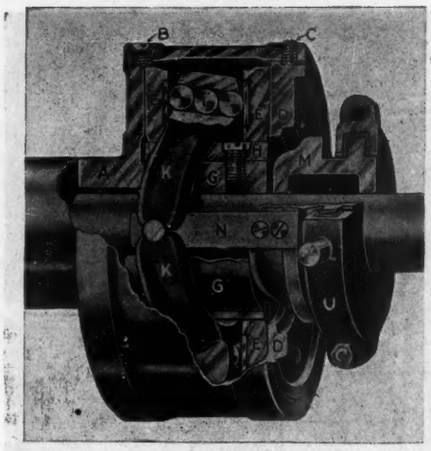
Construction and Operation of Magnetic Clutches

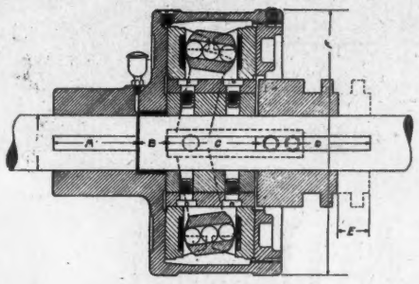
In magnetic clutches the friction surfaces are held together by the direct pull of an electromagnet. When the circuit through the electro-



Construction of single-, double- and triple-disk friction clutches and cutoff couplings.

The two sketches at the left show the construction of cutoff couplings, while that at the right is of a pulley clutch. For extra heavy duty some types of clutches have six or more disks.





Here the clamping action is applied through rollers as shown in the sketch and photograph.

As the clutch is thrown in, the three rollers are forced against the friction surface as shown in the sketch. This clutch is totally enclosed and of comparatively small outside diameter so that it gives low centrifugal action at high speed. Also, with totally enclosed clutches, it is somewhat easier to retain lubrication on the working parts.

magnet is closed, the clutch is engaged; when it is open, the clutch is disengaged. The operation of this clutch is described in connection with the sketch shown below. Some of the advantages claimed for magnetic clutches are: smooth acceleration, ease of operation, elimination of end thrust, and a definite capacity. As it requires a short interval of time for the magnetic action to build up to full strength, the friction surfaces engage gradually and permit enough slip to make a smooth start.

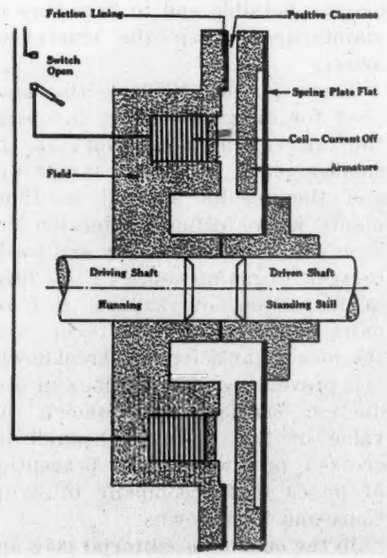
The ease of operation and control is also an important feature as it is only necessary to close or open a switch to engage or disengage the clutch. In this way the control may be handled from almost any position or even at some distance from the mechanism, and may be operated either manually or automatically. It is easier to determine the capacity of a clutch because this is absolutely dependent upon the known pull of the magnet. Also, this capacity is not affected by centrifugal forces which come into play when the magnetic clutches are running at high speed.

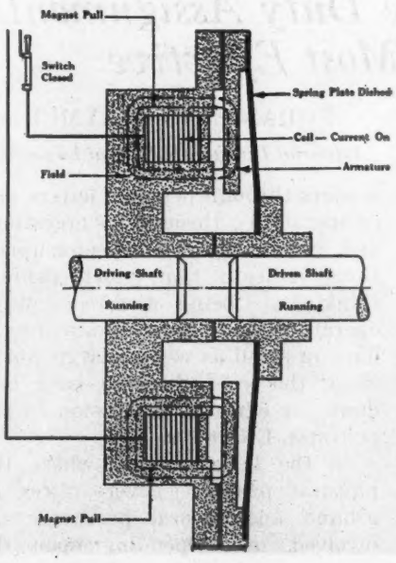
Another advantage, particularly where it is necessary to put a clutch in small space, is that it does not occupy as much space on the shaft as some other types. Like other types of clutches, magnetic clutches may be used in connection with a pulley or sheave and may be built in as a part of it. These magnetic clutches are built in sizes from 7 in. to 78 in., in diameter, and may be used to transmit from 1 hp. to 2,000 hp. As with other clutches they are rated according to the capacity transmitted in horsepower per 100 r. p. m.

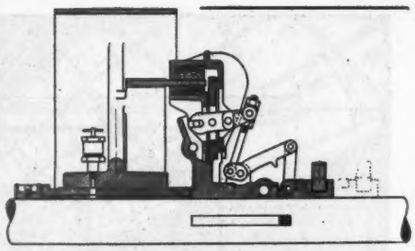
An article in a later issue will take up practical points in the operation of friction and magnetic clutches and couplings together with the information required when selecting equipment to fit the requirements of certain installations.

Diagram showing how a magnetic clutch acts as a cutoff coupling.

The illustration at the left shows the magnetic clutch with the switch open and the magnet de-energized. The driving shaft is running and the driven shaft standing still. When the clutch is energized by throwing in the switch, the magnet pulls the other half of the coupling over until the friction plates are in contact. In this way it picks up the load gradually, as it requires a short time for the magnets to become completely energized, and have both shafts running at full speed. The magnetic action "dishes" the spring steel plate, but as soon as the current is turned off the spring in the plate pulls the flange out of contact and instantaneously disconnects the two parts of the coupling. Electric contact is ordinarily made through collector rings, or slip rings which are mounted on the field hub and are connected to the clutch coils by copper leads. On magnetic clutches, as with all other types of friction clutches, it is essential that the shafts be kept in proper alignment.







A ring-type friction clutch used in connection with a loose pulley.

Here the friction ring is clamped on both sides through a toggle action which engages and disengages the jaws. The pulley is mounted loose on an extended sleeve which is keyed to the shaft. Ample provision must be made for adequate lubrication.

EDITOR'S NOTE: Special acknowledgment is made to the following companies for their assistance in furnishing information and illustrations for this and the other articles which appear in this series: Allis-Chalmers Mfg. Co., Milwaukee, Wis.; The Bartlett Hayward Co., Baltimore, Md.; Charles Bond Co., Philadelphia, Pa.; Bond Foundry & Machine Co., Manheim, Pa.; Brown Engineering Co., Reading, Pa.; The Carlyle Johnson Machine Co., Manchester, Conn.; Chicago Pulley & Shafting Co., Chicago, Ill.; Conway & Co., Cincinnati, Ohio; The Cutler-Hammer Mfg. Co., Milwaukee, Wis.; I. H. Dexter Co., Goshen, N. Y.; Dodge Manufacturing Co., Mishawaka, Ind.; Falls Clutch & Machinery Co., Cuyahoga Falls, Ohio; The Falk Corporation, Milwaukee, Wis.; General Electric Co., Schenectady, N. Y.; The Hanson Clutch & Machinery Co., Tiffin, Ohio; The Hill Clutch Co., Cleveland, Ohio; The Hilliard Clutch & Machinery Co., Elmira, N. Y.; W. A. Jones Foundry & Machine Co., Chicago, Ill.; The Medart Co., St. Louis, Mo.; Mesta Machine Co., West Homestead, Pa.; The Never-Slip Clutch Co., Noblesville, Ind.; R. D. Nuttall Co., Pittsburgh, Pa.; The Pusey & Jones Co., Wilmington, Del.; Reeves Pulley Co., Columbus, Ind.; R. H. & F. M. Roots Co., Connersville, Ind.; A. L. Schultz & Son, Chicago, Ill.; Smith & Serrel, Newark, N. J.; Thomas Flexible Coupling Co., Warren, Pa.; Weller Mfg. Co., Chicago, Ill.; Western Engineering & Mfg. Co., Chicago, Ill.; The Williams Foundry & Machine Co., Akron, Ohio; T. B. Wood's Sons Co., Chambersburg, Pa.

An Analysis of the

Work and Responsibilities of Maintenance Engineers

With Comments by Readers on Divisions of the Work and the Duty Assignments That Have Proven Most Effective

By DANIEL H. BRAYMER

Editorial Director, Industrial Engineer

WHEN INDUSTRIAL ENGINEER was started two years ago as a paper devoted to the operation of electrical and associated mechanical systems in mills and factories we promised to furnish supervising mill engineers and factory department heads who carry the real responsibilities in the operation and maintenance of electrical and associated mechanical systems, practical ideas and information dealing with the fundamentals of good practice rather than theory. In connection with the execution of this editorial plan, issue to issue, we have received the endorsement of hundreds of readers through personal letters and co-operation through suggestions and comments. These communications indicate that much definite thinking is being directed toward operation and maintenance procedure in small as well as large works along the lines that we have laid down for editorial discussion in INDUSTRIAL ENGINEER.

In the larger works where the physical property covers acres of ground and several processes are involved, one depending upon the other, the need for organized effort to prevent interruptions in production or the breakdown of equipment in any one department is obvious. The majority of the larger mills and factories provide a definite organization with well-defined responsibilities in connection with maintenance and operation in all departments of the works. In the smaller mills and factories, however, there is a tendency to keep the wheels turning as long as possible and to take care of maintenance when the emergency arises.

There is, nevertheless, the same need for organized effort in operation and maintenance work in the smaller plant as in the larger one and the results secured in those plants where definite attention has been paid from day-to-day and week-to-week to maintenance in the form of inspection, overhauling and repairs before breakdowns occur, with the idea of anticipating breakdowns and preventing interruptions in production service, have shown the value of this activity through increased production and prevention of losses that accompany interruptions and breakdowns.

In the outline of editorial plan and

scope in the first issue of INDUSTRIAL ENGINEER (January, 1922), the writer analyzed in detail the course of engineering thinking of a technical and research character in the growth of industrial works in this country and pointed out the need for more evidences downward throughout works organizations of a similar application of engineering thinking in operating practices and in the maintenance and operation of the systems that are a part of or auxiliary to manufacturing processes from the standpoint of continuity of service and production costs. Under maintenance is included the upkeep of buildings housing plant equipment and the standards set up for safety to operators and against fire. In this article certain analyses of maintenance work that have already appeared in INDUSTRIAL ENGINEER are summarized to give our readers a broad viewpoint of the work of the maintenance engineers and to point out the phases of it that have been and will be discussed in this publication.

It is generally agreed that engineering work in industrial works can be roughly divided three ways as outlined in the accompanying boxed statement.

In view of fast-growing applications of electric service in industrial works and its close association with the operation of mechanical systems, special editorial consideration is given in INDUSTRIAL ENGINEER to details of service requirements and present practice in meeting them from the viewpoint of the supervising heads responsible for the inspection, overhauling, changing and repairing of the systems involved. In this work both the electrical and mechanical details of the job are discussed. In dealing with any phase of it, a true balance of the practical importance of the electrical and mechanical details are maintained as controlled by the relationship of the electrical and mechanical features that are associated in the operation of any particular mill or factory system.

Industrial Engineering Can Be Divided Roughly Into Three Classifications

1. That calling for the technical services of a civil, electrical, mechanical or other professional consultant.

2. That calling for the services of a professional consultant in the analysis or development of industrial processes or phases of management.

3. That calling for the services of men, in the operating organization of the works, whose training and experience qualify them to be classified among engineers of groups 1 and 2, and also groups of supervisors of work who possess practical experience and the ability to interpret the engineering thinking of their engineer executives and the plans of groups 1 and 2, to modify them as conditions demand, to maintain machine production on an economical basis under changing conditions of plant growth or new requirements with a view to maintaining continuity of service and controlling production costs.

It is to the Industrial Engineers who make up group 3 that this paper is particularly addressed—these men who represent the execution of engineering thinking in the various departments of an industrial works and carry out in a practical way the ideas and ideals of management in the processes of production.

In the past, the work of these men has been in the main a job and we are wrapping this paper around the various phases of that job in such a way as to analyze its practical phases and help them to organize the work on the best lines of engineering practice.

In this connection INDUSTRIAL ENGINEER is rendering a new and complete service to a group of men who are doing worth-while things and represent a phase of engineering thinking in the operation of American industries that will expand and grow in importance in proportion to the expansion of the physical proportions of industrial works and the added complication of production processes.

Men in charge of works operations in industrial plants are interested these days in production control methods and other ways of keeping production at a maximum in quantity and in economy. They are looking for men who possess imagination, initiative and an ambition to take on the responsibility of executing ideas and plans that will keep works equipment and processes run-

Airplane view of the Eddystone plant of the Baldwin Locomotive Works, located near Philadelphia, Pa.

This plant covers 596 acres. The maintenance department must be able to cover a wide territory and be so organized that a call from any department can be responded to in short order.

ning smoothly, economically and without costly interruptions.

Responsibilities of Two Groups of Men in Industrial Works

When discussing output of an industrial works, its quality, cost and profit with existing equipment and known labor costs, the thinking of two groups of men is represented. The first group includes those who make up the executive organization and think about production schedules and necessary engineering development and design from the executive viewpoint of translating orders received into products that can be shipped. The second group includes those men who carry the responsibility of executing the ideas of the executives and the engineering force, in the departments of the works that are required to turn out the product from its raw state into its finished form.

This second group of men directly in charge of works operations is interested in production control methods and all other ways of keeping production at a maximum in quantity and in economy. They employ as assistants men who have the ability to carry the responsibility of keeping works equipment and processes running smoothly by correcting faults before they become serious.

The men making up this second group and their assistants are the men to whom INDUSTRIAL ENGINEER is addressed. In fact, INDUSTRIAL ENGINEER is built along the lines of the thinking of these men who are analyzing and laying out production methods from the standpoint of securing better operation, fewer interruptions and maximum output. The articles that are published deal with the details of actual jobs exactly as a man faces them when they come to him. The articles take up the work to be done step by step as it proceeds so that he gets a full, rounded view of the whole problem being discussed because it is presented in exactly the way that he must handle it. Moreover, INDUSTRIAL ENGINEER is furnishing to the plant man who has a supervising responsibility something that will cause him to think more analytically about his work in terms of production.

To those men who supervise work and those who actually carry out its details, INDUSTRIAL ENGINEER is presenting definite analyses of how work is done in different kinds of plants with step-by-step procedure and the results which have been accomplished, together with the methods which have brought these about.

For men responsible for the operation and maintenance of electrical and associated mechanical systems in all industrial works INDUSTRIAL ENGINEER aims to be a handbook of better operating practices and of the ways other men are handling maintenance problems. Moreover, it is their guide to reduced operating costs and the elimination of waste through reduction of costly shutdowns. The problems discussed are those that lie along the path of power service which extends from the point where power service is received in the plant through all the equipment which represents power service up to the driven element of machines engaged in production.

The Path of Power Service in Industrial Works

In this line or path of power service INDUSTRIAL ENGINEER takes up the complete electrical and associated mechanical parts of the units or systems involved. In the case of a motor driving a machine such as a lathe we start at the main switchboard, go through the main and branch electrical circuits and motor control equipment to the motor shaft through the belts, chains or gears to the main and counter shafting, if there be such, and through the belts again to the pulley of the machine that is actually engaged in production and depending upon this path of power service for continuity of operation.

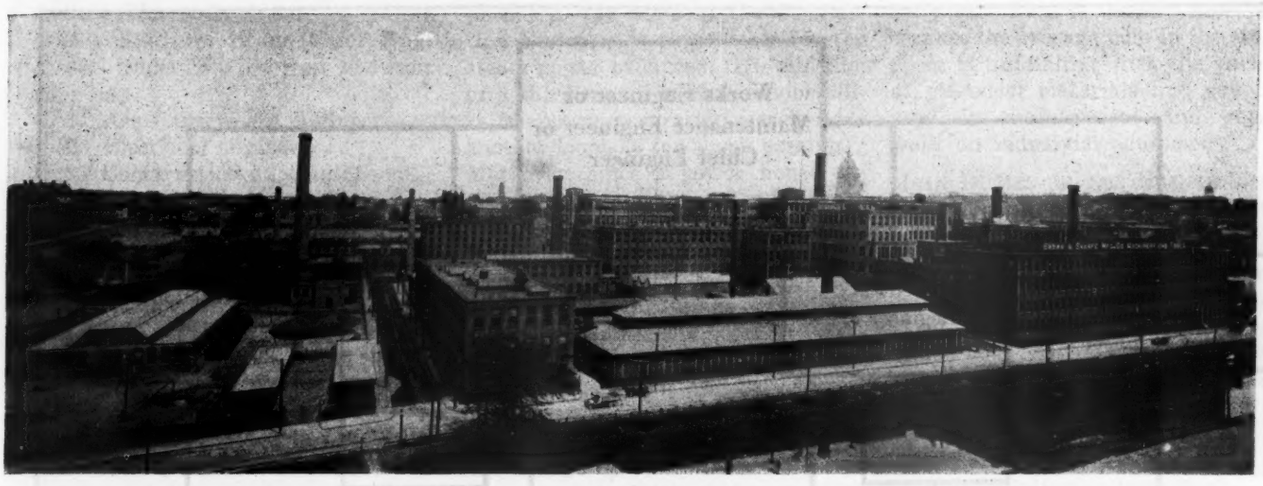
In the case of a conveyor, which again is inserted in the line of power service to machine or to different departments of a plant, we begin at the switchboard and go through all the circuits and control to the motor driving the conveyor and through the chain of mechanisms that the conveyor includes as a unit right up to the point where the service of this conveyor ends and the work starts again on a detail or process of production and is not riding on an element of power service to machines or to departments.

This is what we mean by operation and maintenance of electrical and associated mechanical systems or units in a plant.

Maintenance engineering and pro-

Below is a bird's-eye view of the McCormick Works and Tractor Works of the International Harvester Company in Chicago, Ill.

An electrical or mechanical drive failure in a plant such as this causes a loss in production which not only affects the immediate machine, but may shut down a section of the works before and after the machine, provided the delay is of sufficient duration. The plant illustrated above is devoted to the manufacture of McCormick reaping and harvesting machinery, with the Tractor Works in the distance. The different divisions of this plant are as follows: (1) Works and engineering offices, assembling and finishing rooms; (2) malleable iron foundry; (3) grey iron foundry; (4) paint factory; (5) knife and grinding shop; (6) bolt and nut shop; (7) wheel shop; (8) forge shop; (9) wood shop; (10) finished product warehouses; (11) raw material yards; (12) raw material sheds; (13) twine mill; (14) freight house; (15) locomotive house; (16) tempering shop; (17) spring shop; (18) paint-grinding shop; (19) chemical laboratory; (20) No. 5 warehouse transfer agency; (21) hospital; (22) fire and watch service station; (23) garage; (24) barn; (25) motor truck shed; (26) and (27) replacement parts shipment and storage; (28) oil pump-house; (29) tractor works; (30) clubhouse.



Plant of Brown & Sharpe Mfg. Co., located at Providence, R. I.
Maintenance operations play the same important role in this type of plant as in the continuous-process plants. Although a production delay may not mean a waste of material, the loss in production may be very large.

cedure in industrial works is as long and as broad as the area covered by the structures in which the work of production is carried on. It is as complicated as the equipment and processes that are used, yet it is less organized than the work of production at machines, although it is of equal importance and an essential element in any program of production that aims to be economical from an operative standpoint with avoidable accidents and breakdowns reduced to a minimum.

Details of Duties and Responsibilities of a Maintenance Organization

Based on the studies that the editors of INDUSTRIAL ENGINEER have made personally by visits to plants and by correspondence, we have devised a form of organization and details of duties and responsibilities of men in charge of maintenance work which is presented diagrammatically on pages 10 and 14.

In this connection we would like to point out that an ideal works maintenance organization should:

1. Get the work done.
2. Maintain the plant at its highest efficiency.
3. Function with the least friction with other departments.
4. Be so organized as to directly fix the responsibility for every important job on some one man.

The details of an ideal works maintenance organization may vary somewhat in the different industries, but the general arrangement is somewhat the same for all of them. The head of the factory or works organization is usually known as the Works Manager or General Superintendent. Under his supervision are three main departments:

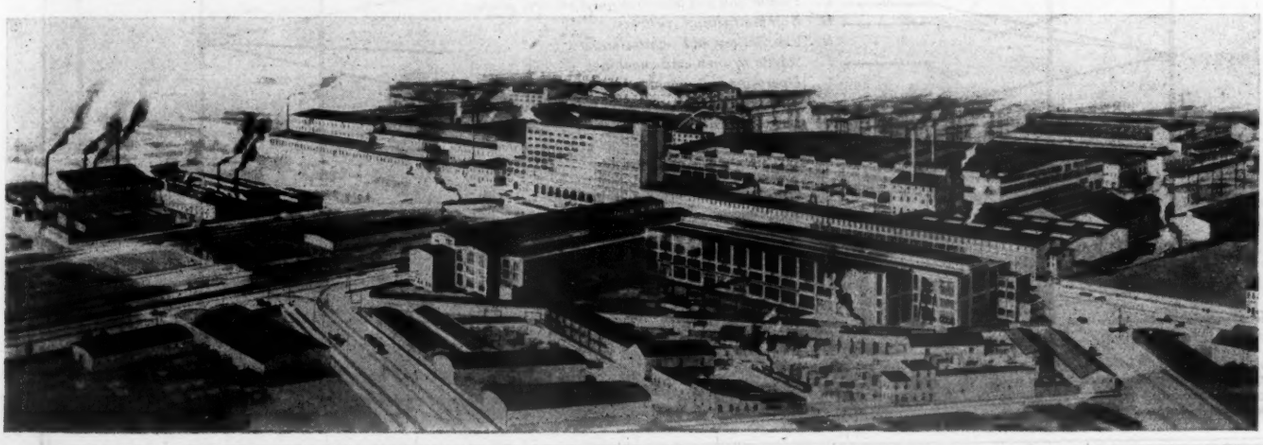
1. The works maintenance department.
2. The production department.
3. The accounting department.

In some industrial works such as the automobile plants and the railway car building factories, there is a fourth department known as the engineering department which has charge of design of the product manufactured. There is also what might be considered a fifth department, the safety department, which does not rank with the rest of the departments, yet reports directly to the Works Manager the same as the other four subdivisions.

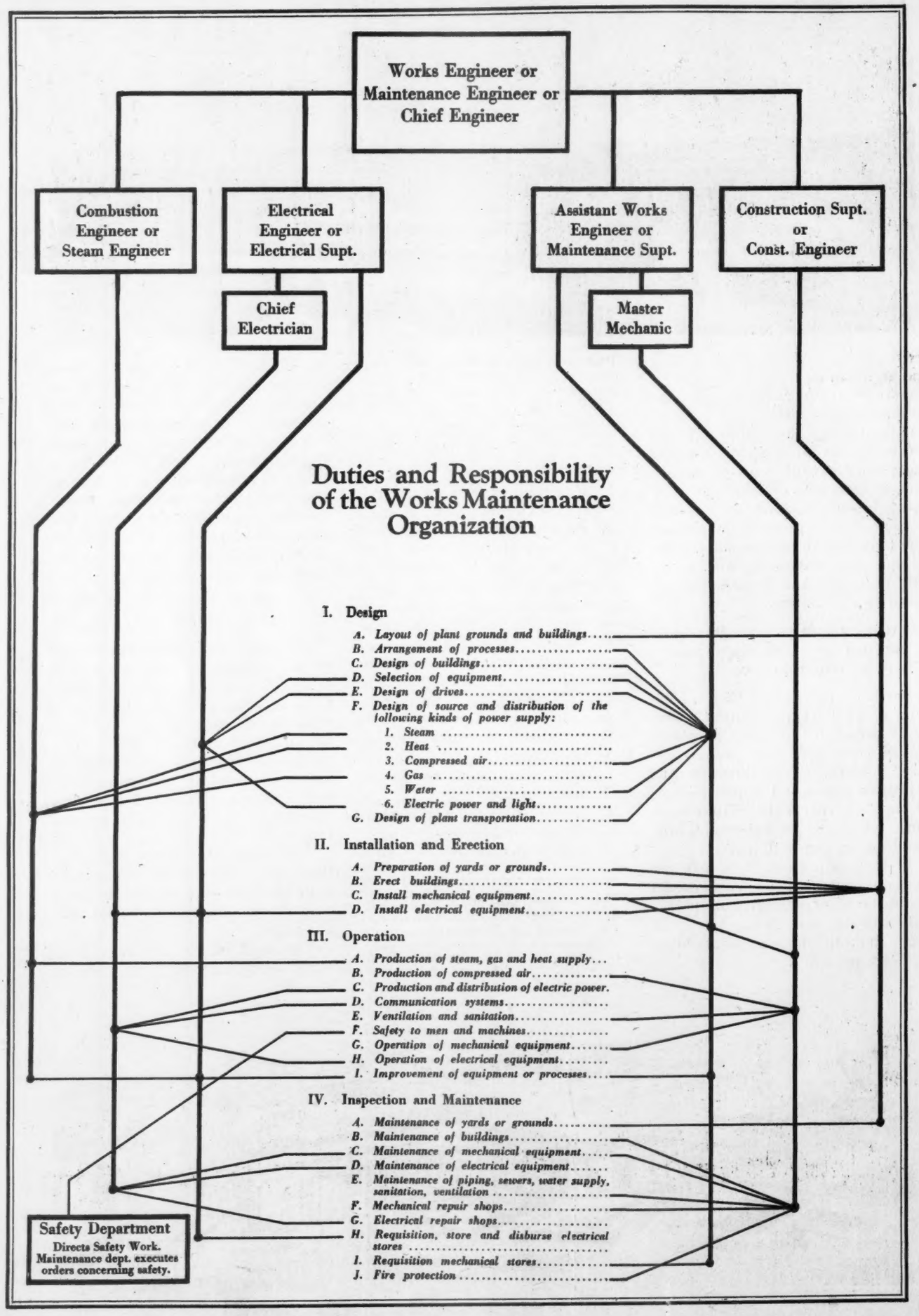
The Works Engineer and His Staff

The safety department has charge of all matters pertaining to the safety of machines and employes. This department directs the works maintenance department and the production department in this respect. The maintenance department makes and installs the safeguards and safety devices which are used throughout the plant. The production department enforces the orders of the safety department regarding their use. The safety department quite often is part of a department that also has control of employment and police.

The head of the works maintenance department is usually known



This is the plant of Wm. Cramp & Sons Ship and Engine Building Co., located at Philadelphia, Pa.
Maintenance plays an important part in the continuity of production in a shipyard of this size.


Works Engineer or Maintenance Engineer or Chief Engineer
Combustion Engineer or Steam Engineer
Electrical Engineer or Electrical Supt.
Assistant Works Engineer or Maintenance Supt.
Construction Supt. or Const. Engineer
Chief Electrician
Master Mechanic
Duties and Responsibility of the Works Maintenance Organization
I. Design
A. Layout of plant grounds and buildings
B. Arrangement of processes
C. Design of buildings
D. Selection of equipment
E. Design of drives
F. Design of source and distribution of the following kinds of power supply:
1. Steam
2. Heat
3. Compressed air
4. Gas
5. Water
6. Electric power and light
G. Design of plant transportation
II. Installation and Erection
A. Preparation of yards or grounds
B. Erect buildings
C. Install mechanical equipment
D. Install electrical equipment
III. Operation
A. Production of steam, gas and heat supply
B. Production of compressed air
C. Production and distribution of electric power.
D. Communication systems
E. Ventilation and sanitation
F. Safety to men and machines
G. Operation of mechanical equipment
H. Operation of electrical equipment
I. Improvement of equipment or processes
IV. Inspection and Maintenance
A. Maintenance of yards or grounds
B. Maintenance of buildings
C. Maintenance of mechanical equipment
D. Maintenance of electrical equipment
E. Maintenance of piping, sewers, water supply, sanitation, ventilation
F. Mechanical repair shops
G. Electrical repair shops
H. Requisition, store and disburse electrical stores
I. Requisition mechanical stores
J. Fire protection
Safety Department
Directs Safety Work. Maintenance dept. executes orders concerning safety.

as the Works Engineer, as Maintenance Engineer or as Chief Engineer. Under him are men who function as:

1. Assistant works engineer.
2. Electrical engineer.
3. Construction superintendent.
4. Combustion engineer.

These four men are of the same rank and each has direct control of his own division, subject only to the supervision of the Works Engineer. The organization of the repair shop, maintenance men and power production for each division is shown in the organization diagram.

Under the Assistant Works Engineer are all of the mechanical shops and mechanical maintenance men except the crane machinists. These are under the electrical organization because the most important features of the cranes are electrical and it has been found that more satisfactory operation of the cranes can be obtained by co-ordinating the mechanical and electrical work under the electrical department.

Under the Electrical Engineer come the electric repair shops, motor inspectors, electrical construction men, the plant communication systems, crane maintenance and the electric power generation and distribution.

The Combustion Engineer has charge of the boiler houses. His authority should extend to the steam header in the power house. The steam engines or turbines instead of being under the mechanical department (Assistant Works Engineer) should be under the electrical department. The reason for this is because the electrical department is responsible for the electric power produced, the same as the Combustion Engineer is responsible for the steam power produced. The addition of a third man into the responsibility for power generation merely adds another loophole for "buck passing." Moreover, since a power house engineer is required for handling the work in the power house, it has been found that the best results can be secured by getting a mechanical man with turbine or engine experience and teaching him the necessary electrical knowledge required for handling the power house switchboard operators.

The Construction Superintendent has charge of all construction in a general way. His duties and responsibilities will be detailed later.

The only channel through which the works Auditor comes in direct contact with the mechanical and electrical department is through the handling and use of stores and spare parts. The mechanical department usually requisitions and stores their own spare parts; the ordinary stores are usually requisitioned and stored by the general stores department which is directly under the works Accountant. The electrical department differs from the above in that they not only requisition and store their spare parts, but also requisition, store and disburse all electrical supplies. This is usually necessary because the average help in the storeroom is unfamiliar with the variety of electrical materials and supplies used in maintenance and repair work on industrial equipment.

Main Duties of the Maintenance Organization

In the diagram of duties and responsibilities the duties of the works maintenance organization are divided among the four department heads who are directly under the Works Engineer. These duties are also subdivided into groups as follows:

1. Design.
2. Installation and erection.
3. Operation.
4. Inspection and maintenance.

It will be noticed that all the four department heads (Electrical Engineer, Assistant Works Engineer, Construction Superintendent and Combustion Engineer) are directly responsible for the design work.

The installation and erection duties are the direct responsibility of the Construction Superintendent. The erection and installation of mechanical and electrical equipment is done by the electrical and mechanical departments under the general supervision of the Construction Superintendent. This supervision is confined to locating the position of the various units of apparatus. The Master Mechanic and Chief Electrician usually do the installation work directly under the supervision of their superiors.

All inspection and maintenance duties except the requisitioning of stores material are the responsibility of the Master Mechanic and the

Six thousand men and women are employed in this Bayonne, N. J., refinery of the Standard Oil Company.

The refining of crude oil is a continuous process. An interruption of the process means a waste of product and if the interruption is of long duration it may endanger not only the equipment but also the lives of the operators. A high order of inspection and maintenance is necessary in a plant of this kind to secure economical production.

Chief Electrician. The requisitions for mechanical and electrical equipment usually originate with the Master Mechanic and Chief Electrician.

The duties and responsibilities of electrical men in industrial work from a production standpoint are for the most part new. The extensive use of electrical service even in our large plants and the revision of mechanical details for such operation, is a product of our present generation of workers, most of whom are still young. And those who have established for themselves jobs that carry recognition have had to fight their way to such recognition. It will not always be so. For management, even when most conservative, places responsibility on those who show results and on this basis maintenance engineers in industrial works have a much brighter future than they may now realize. But nothing will be handed to them on a silver platter—it's results that count and of these there are aplenty that are gradually but forcefully making a dent in the consciousness of industrial executives.

Four Elements of Maintenance and Operation

THE EDITORIAL SERVICE of INDUSTRIAL ENGINEER is wrapped around the practical details of everyday jobs. For men responsible for the operation and maintenance of electrical and associated mechanical systems in all industrial works it is their handbook for better operating practices and the ways other men are handling maintenance problems. Under maintenance is included the upkeep of buildings housing these systems and the standards set up for safety to operators and against fire.

Articles in the paper deal with the problems that lie along the path of power service that extends from the point where power service is received in the plant through all the equipment that uses power service up to the pulley of the machine engaged in actual production. In this line or path of power service INDUSTRIAL ENGINEER takes up all of the electrical and associated mechanical parts of the systems involved.

MEN IN CHARGE of works operations in industrial plants are interested these days in production control methods and other ways of keeping production at a maximum in quantity and in economy. They are looking for men who possess imagination, initiative and an ambition to take on the responsibility of executing ideas and plans that will keep works equipment and processes running smoothly, economically and without costly interruptions.

In every works the responsibility for production is carried by a group of men—those who supervise work and those who actually carry out its details. To the men on whom this responsibility rests INDUSTRIAL ENGINEER is addressed. In fact, INDUSTRIAL ENGINEER is built along the lines of the thinking of these men who are analyzing and laying out production methods from the standpoint of securing better operation, fewer interruptions and maximum output.

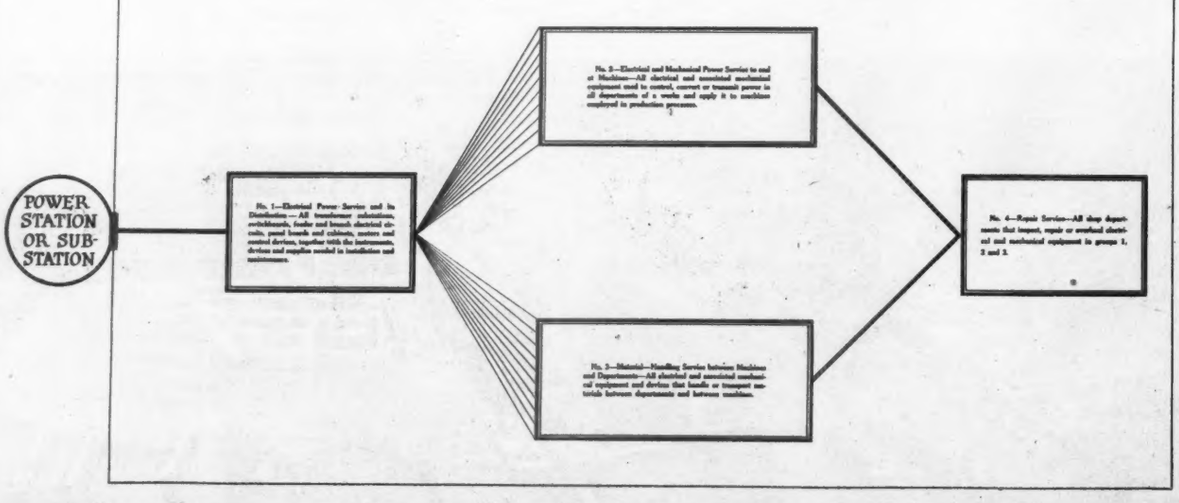
ARTICLES that are published deal with the details of jobs being done day by day. Moreover, INDUSTRIAL ENGINEER is furnishing to the plant man who has a supervising responsibility, something that will cause him to think more definitely and analytically about his work in terms of production.

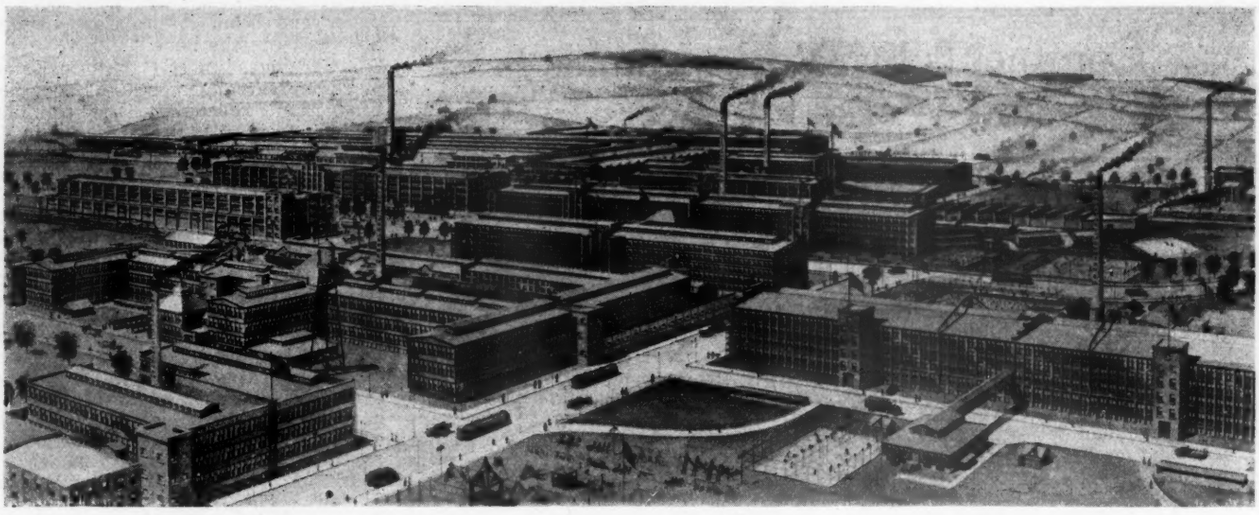
To these groups INDUSTRIAL ENGINEER is presenting definite analyses of how work is done in different kinds of plants with step-by-step procedure and the results which have been accomplished together with the methods which have brought these about. It is a handbook of procedure and helps a man who is groping around for practical information to put his hand on something concrete that he can use in doing a job. In brief, the articles presented are written around the practical details of everyday work in industrial plants—such work as installation, inspection, overhauling and repair—and deal with the different phases of these jobs exactly as a man faces them when they come to him in his own plant.

They take up each job step-by-step as he proceeds in the work so that he gets a full, rounded view of the problem which is discussed because it is presented in exactly the way he must handle it.

Editorial Scope of Industrial Engineer in dealing with the maintenance and operation of electrical and associated mechanical systems in Mills and Factories.

The four elements of maintenance and operation discussed along the line of Power Service between substation or plant switchboard and machines engaged in production.





A composite picture of the Endicott-Johnson Corporation's factories at Endicott and Johnson City, N. Y.

In works of this kind, frequent inspection of equipment will greatly reduce repair bills. Particular attention should be paid to inspections when operations cover a wide area and there is a large amount of equipment.

Some Comments on Maintenance Work by Readers of Industrial Engineer

INDUSTRIAL ENGINEER has conducted numerous investigations to determine the procedure and practices now in operation that have been most effective in preventing interruptions in plant service and breakdown of equipment. During the past two months we have written a number of letters to our readers who are Works Managers, General Superintendents, Electrical Superintendents, Chief Electricians, Mechanical Superintendents and Master Mechanics and have studied the problems of plant maintenance, established an organization to carry it on and devised practices which indicate the best procedure to follow. In this connection we have asked the questions shown in the box in the next column.

On the following pages comments are presented from 24 readers of INDUSTRIAL ENGINEER in charge of maintenance in a wide variety of plants. These comments are well summarized in the statement by K. D. Hamilton, Mechanical Engineer of the George E. Keith Company, makers of Walkover shoes at Campello, Mass.:

The duties and responsibilities of the man in charge of the maintenance and plant operation of any well-organized institution are very broad. He should be willing to put his time and energy into solving any problem which may come up, whether it be one of production, one of new construction, or one of maintenance.

The Plant Engineer or Mechanical Engineer in charge of any large plant is responsible for any problem which comes up other than those relating to the direct production problems or policies of the institution. His responsibility covers plant repairs, plant construction, designs, boiler and engine plant equipment and operation, power transmission, electrical as well as mechanical, sprinkler system, fire protection, plumbing department, watchmen and fire alarm systems, safety engineering, machine design, machine maintenance and operation, invention of new processes pertaining directly to the production problem. Anything which comes to his attention should be taken up gladly and given his best attention. The best organization is to have one man responsible for the entire plant. Under him should be the necessary foremen, such as electricians, machinists, millwrights, blacksmiths, steam fitters, carpenters, engineers, etc.

The maintenance organization can show the greatest saving in performing their work at the least cost, keeping the plant in constant operation, and eliminating shutdowns.

Questions Asked Readers of Industrial Engineer

1. What are the main duties and responsibilities of men in charge of maintenance and plant operation in a well-organized works?
2. What lines of work come under their supervision and how can they best organize a force to handle installation, inspection, maintenance and overhauling of electrical and its associated mechanical equipment? In this connection what work can best be handled by the Chief Electrician and what work by the Master Mechanic?
3. What kind of changes or rearrangements are men in charge of maintenance most often requested to work out?

The other letters, however, bring up points of interest in connection with maintenance work and definitely show that maintenance engineers have an important field in industrial work where there is a need for more recognition by their executive superiors on the basis of the importance and the value of the work they do in keeping machines running and production flowing smoothly and with a minimum of interruptions due to preventable causes.

Efficient and smoothly running works turning out maximum production on schedule time do not just happen. They are the logical result of the thinking and planning of men whose job it is to prevent all interruptions in machine production and power service. These men can come closer to estimating the effects of natural wear and tear than anyone else in the plant, for they are working with the equipment every day and know its weak and strong points.

Comments by Works Managers and Works Engineers

C. D. Corwin, Works Engineer, Corona Typewriter Co., Inc., Groton, N. Y.: 1. The main duties and responsibilities of men in charge of maintenance and plant operation may be briefly outlined as follows:

Maintenance and plant operation require men of practically every trade with the possible exception of paperhangers and stonesetters. The man in charge of maintenance and plant operation should be broad gauged, for he has as his main duties the selection and organization of the proper men to handle the many diversified problems which go to make up maintenance. He should so organize his force as to properly and efficiently operate the plant and to maintain all of it in first-class condition at all times. He should secure the confidence and co-operation of the men under his charge to the end that every individual will have the company's interest at heart, and will be on a constant lookout to render better service to all departments. He should establish a suitable inspection routine in order to anticipate failures and to make the necessary repairs and adjustments before serious breakdowns can occur. Much money may be saved and much lost time prevented by such regular inspection.

2. The maintenance organization should be responsible for all lines of work in maintaining the entire plant in the most efficient operating condition including the aesthetic and sanitary features. The Chief Electrician can best handle all electrical equipment. The Master Mechanic can best handle all other equipment. It is presumed here that the title Master Mechanic is synonymous with Plant and Works Engineer, and that if the size of the plant demands it there shall be various divisions, each with its foreman, for instance: machinery maintenance, tool maintenance, building maintenance, factory maintenance and safety work, and so forth.

3. Relocation of pipe lines and machinery to better facilitate routing of work are the important and frequent changes made. The maintenance organization should have information on various types of roofs, concrete and brick exteriors, concrete floors, window washing, removal of obnoxious fumes and wastes.

John E. Payne, Works Engineer, American Malleables Company, Owosso, Mich.: 1. I believe that the main duties and responsibilities of men in charge of maintenance and plant operation in a well-organized works, consists mostly of planning new installations, getting better results from existing equipment and systems, planning more economical methods and handling the unexpected problems which arise in all plants and require cool thinking and decisive action.

2. The work which comes under their supervision is highly varied in different plants. Personally, I am responsible for the entire mechanical and electrical equipment, also the buildings. My organization consists of an Assistant Master Mechanic and Chief Electrician, with one man under him, one machinist and helper, two millwrights and helpers as required, one or two electricians and helpers as required, one construction foreman and gang, one head carpenter and assistants as needed, one blacksmith and helper, day and night fireman for heating plant only, plant machinery oiler and plant watchman. When the Master Mechanic and Chief Electrician are under one head, it prevents disputes and "passing the buck."

3. Changes mostly requested are machine rearrangements to meet new production schedules and building changes to meet new conditions.

W. T. Price, Works Manager, Westcott Valve Co., Seneca Falls, N. Y.: 1. The main duties of the men who look after maintenance in our plant are to install all new equipment and keep same in good running order, as well as to keep all machinery, motors and compressors in good running order.

2. We have about thirty-three motors, all started by men appointed to do the starting. The inspection of same is taken care of by the maintenance department, along with the cleaning and oiling. Maintenance department men are directly under the Works Manager or General Superintendent. The General Superintendent does all figuring for changes of every kind, but also advises with the foreman of maintenance department. Repair parts should be kept in stock for all fuses, as well as an extra set of fuses for each fuse box and for motors thrown directly across the line; twelve fuses should be stocked.

Almost all of our motors are protected with overload relays and, also, an automatic controller on the direct line between fuse board and transformers. We have had practically no trouble with our electric equipment in four years.

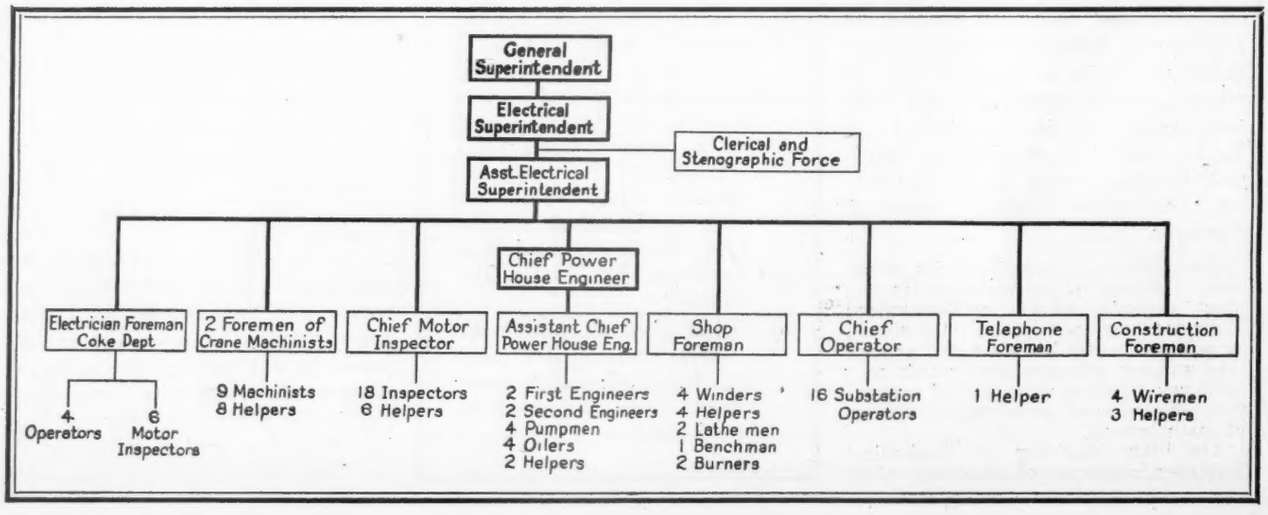
H. B. Emerson, Superintendent, Arlington Mills, Lawrence, Mass.: 1. The main duty of the man in charge of maintenance and plant operation is to keep the plant in condition for the maximum amount of production at a minimum cost.

2. All work pertaining to installation, proper up-keep, efficient operation (including lubrication) and life maintenance, should come under this man's supervision. His force must be organized so as to efficiently take care of the above work at a minimum cost, and to be maintained so that there will be no divided responsibility in the work.

The position of the plant will in a measure decide whether the electrical and mechanical repairs can best be handled by a force within its own organization or by an outside party. In a number of industrial centers outside parties have made a special bid for

Organization chart showing the plan by which the work of the electrical department is supervised.

In addition to the superintendent, his assistant and the office force, the department consists of 112 men. There are ten men who rank as immediate supervisors on the job, and 102 workmen. The construction section is expanded at times to provide for the existing construction requirements. Operators working in the coke department are shown under the authority of the coke department electrician foreman, because the coke department is somewhat removed from the rest of the plant so that the chief operator is at a disadvantage in supervising these men.



such work and owing to the amount of work handled and the specific equipment in their shops, can do better, quicker, and cheaper work than by a force maintained in an individual plant.

The Chief Electrician should take care of all electrical operation and maintenance, calling on the Master Mechanic to do any purely machine repairs. The Master Mechanic should be responsible for all machine installation, operation and maintenance.

3. In a properly designed plant, changes and rearrangements should be unheard of, as a modern plant today is generally laid out with the idea of future increase in a certain direction. In old plants all kinds of changes and rearrangements to facilitate production must be made and the man in charge of maintenance will undoubtedly be asked to help work out these special problems.

An industrial engineer must be as resourceful in maintenance methods as a country doctor is in diseases of the body and mind and must, as does the country doctor, diagnose each individual case and then apply the proper remedies to get the best results.

Comments by Mechanical Engineers and Master Mechanics

K. D. Hamilton, Mechanical Engineer, Geo. E. Keith Co. (Makers of Walk-Over Shoes), Campello, Mass.: To answer all of the questions which you have mentioned in the detail in which they should be answered would require several pages of typewritten matter.

1. The duties and responsibilities of the man in charge of maintenance and plant operation in any well-organized institution are very broad. He should be willing to put his time and energy into solving any problem which may come up, whether it be one of production, one of new construction, or one of maintenance.

2. The Plant Engineer or Mechanical Engineer in charge of any large plant is responsible for any problem which comes up other than relating to the direct production problem or policies of the institution. His responsibility covers plant repairs, plant construction, designs, boiler and engine plant equipment and operation, power transmission, electrical as well as mechanical, sprinkler system, fire protection, plumbing department, watchman and fire alarm systems, safety engineering, machine design, machine maintenance and operation, invention of new processes pertaining directly to the production problem. Anything which comes to his attention should be taken gladly and given his best attention. The best organization is to have one man responsible for the entire plant. Under him should be the necessary foremen, such as electricians, machinists, millwrights, blacksmiths, steam fitters, carpenters, engineers, draftsmen, and so on.

3. The maintenance organization can show the greatest saving in performing its work at the least cost, keeping the plant in constant operation and eliminating shut-downs. The greatest direct saving can be made in the reduction of power and fuel bills.

4. The changes and re-arrangements of problems presented to men in maintenance work are many. Most of them are machine details, new construction and power plant work. INDUSTRIAL ENGINEER can help in attacking any one of the various phases of the maintenance engineer's work and pointing out certain practices used in large industrial plants.

J. P. Hines, Master Mechanic, Lever Brothers Company (Makers of Lux, Rinso, Lifebuoy, Pear's and other soaps), Cambridge, Mass.: Your letter asking for comments on various subjects is at hand and I take pleasure in submitting the following, trusting that you may be assisted by it in compiling data which will go to show that maintenance engineers have an important field in industry; also to show the need for giving the maintenance engineer more recognition on the basis of the importance and value of the work that he does.

The main duties and responsibilities of men in charge of maintenance and plant operation in a well-organized works are as follows:

1. To keep the plant in a running condition at all times.
2. To lay out new installations.
3. To advise regarding the increasing or decreasing of the number of employees coming under their supervision.
4. To study the products with the idea of simplifying their process of manufacture both from a cost and from a production standpoint.
5. To advise regarding the selection of new equipment to be installed in order to determine the best and most economical types to meet the conditions.
6. To make a study at all times of every possible precaution to safeguard both the machinery and operator from injury.
7. To keep accurate records from day to day of the major happenings of the plant's operations, such as power, water and gas consumption, accidents, and the like. These records will often prove of invaluable service in settling questions of future development as well as placing the responsibility for past happenings.

The principal work coming under the supervision of the maintenance organization is: repairs, new installations and plans for future expansion.

At our plant we have a Master Mechanic who reports directly to the Plant Engineer, to whom he is directly responsible. His duties are to handle all new installations, inspections, general maintenance, and overhauling of electrical and mechanical equipment. Directly under the Master Mechanic comes his staff of assistants, consisting of chief draftsman, foreman steamfitter, foreman carpenter, chief electrician, foreman machinist, chief engineer of the power house, and head janitor. It is the duty of each of these assistants to carry out such orders as come under their individual departments, such orders originating in the Master Mechanic's office. The Master Mechanic supervises the work of each department and gives his final O. K. when such work has been completed satisfactorily.

A well-organized repair force in a plant can, to my mind, make the greatest saving to the organization. Repairs are generally looked upon as a source of expense and in most works are put off until the last moment. If an actual breakdown occurs the more efficient the maintenance organization the quicker the wheels can be started again. It is much better, however, for all concerned if the breakdown does not occur, and the practice we adopt at our plant is to make a thorough inspection of machinery whenever the opportunity presents itself. If parts are found badly worn they are taken out and replaced. Sometimes a part can be repaired and made as good as new. This part can then be held for a spare. **An invaluable asset to the maintenance organization is to have in charge those who know when parts should be repaired and when they should be discarded and replaced for new ones.** Many times perfectly good parts are discarded by the inexperienced when they could be readily repaired. On the other hand it is quite often the case that valuable time is lost trying to repair parts that can be purchased new for half the money.

The kind of changes or re-arrangements that men in charge of maintenance are most often requested to work out should be grouped under four heads as follows: 1. Changes due to growth or expansion. 2. Changes for improving the quality of the product. 3. Changes for shortening the process of manufacture. 4. Changes to make way for future development.

Geo. S. Neeley, Master Mechanic, International Shoe Co., S. Wood River, Ill.: 1. The duties and responsibilities of our maintenance department cover everything and anything, mechanical or electrical, that could arise in a plant of the size and character of this one. 2. The installation of motors, replacements, removals of bearings, inspection of motor drives, chains and sprockets for alignment and lubrication, tests for grounds and removing of same, installation and maintenance of lighting system, are duties that are assigned to the first electrician and a helper. Where the work involved is purely mechanical, the electrician usually turns this part of the work over to the mechanics of the department but stays on the job until every item of work is complete and all apparatus is in normal service.

As Master Mechanic, I do not interfere in regular routine repair work unless results are not as rapid as the circumstances would seem to warrant. I have been able to develop better initiative in repair men by making it a practice not to interfere with the men when once they have a clear layout as to what is required. I happen to possess a rich experience in both electrical and mechanical lines, and therefore keep in close touch with all branches of new and maintenance work involving these lines of endeavor. This is evidenced in our output which is easily 75 per cent more than the institution was de-

signed to produce, as against only a little more than one-fourth its capacity four years ago, which was the best they could get out of the plant under the conditions that then existed.

3. As head of the maintenance department of this plant, I have had a hand in working out many details of operation that have resulted in such advantages that patents have been applied for in order to protect the ideas involved. A good maintenance department can do wonders for any industrial plant, by close observation and applying common-sense, tried-out, mechanical-electrical methods. The job is generally what the head of the department chooses to make of it—he can easily make it so efficient that every other department really leans upon him for counsel and support; or he can so conduct his department that the reverse of this is true. I have seen both types in operation.

4. Our line of maintenance is a little different from the average, owing to the greater variety of leather-working machinery in use throughout this type of plant. We can apply anything in the electrical and mechanical lines that suits our case, but, usually our immediate requirements lie in a field outside these two lines.

H. W. Hill, Master Mechanic, Anderson Foundry & Machine Co., Anderson, Ind.: 1. The duties and responsibilities of maintenance men vary so much in different plants that it would be a hard matter to establish a standard. Each chief that I have worked under has had different ideas, but my main idea is this: When a large installation or change is contemplated take all men concerned into consultation and see that new plans are satisfactory to every one concerned. I had the pleasure of trying that in one factory with great results. To sum it up in one word, it is—co-operation!

2. In our plant we have two electricians, two millwrights, one belt and lineshaft man, and three helpers, one of whom does winding in spare time.

Albert M. Shatto, Cleveland, Ohio: I have found that to gain headway in any plant requires a lot of co-operation by all employes. The Master Mechanic who has the best interests of his company at heart is always planning something better for the future. If a certain machine is not giving the required service he finds the cause. If a belt drive is the cause of trouble he will try a silent chain or a direct-gear drive. If the cast-iron pinion does not stand the strain he orders cast steel or a steel machined one and so on until the proper one is found to do the work and stand the required strain. And what is true of a machine is true in all factory lines from its foundation to the top of the building.

He should know the place to use wood in construction and the proper place to use steel, brick, stone or cement and have a working knowledge of the different materials. He should have men at his command who can go into any branch of his factory and make repairs according to his instructions. The Master Mechanic is the one who is always looked to, to keep the wheels going and the first one to be called upon when they stop. He is always checking up on new parts for machines, so that if anything breaks he has the new part to put in and continue production.

The duties of the Chief Electrician, as I understand them, are to have full charge of all electrical equipment. He should keep a check on all stock required for his department. His personal supervision should be respected and his effort to keep things in the best condition should have the co-operation at all times of the Master Mechanic. In putting in new machines the Chief Electrician should always see that conduits are properly placed and after foundations are finished that nothing will interfere with setting of motors or other equipment.

The kind of changes that men are required to work out deal largely with handling of materials. Today everything must be elevated and conveyed by car or track system. Elevators are driven either by belt or sprocket chain and we must find the best type for the material to be handled. If the material is too plastic and fills the elevator buckets and can not be thrown out at the discharge end, then we must turn to something that will handle the material such as the drag flight conveyor of proper design.

INDUSTRIAL ENGINEER can best serve its purpose by publishing articles on handling machine parts in construction work and repairs of all kinds, as well as articles on new equipment, setting forth the most up-to-date method of handling and doing things.

Comments by Electrical Engineers and Chief Electricians

Philip C. Jones, Electrical Engineer, The Goodyear Tire & Rubber Company, Akron, Ohio: There are at least two distinct systems of maintenance. With one method machines are allowed to run with no attention other than oiling until they break down. Then an order is put in and they are repaired. With the other system, machinery is periodically inspected and small repairs made constantly with the intention of never having a breakdown. Both of these systems may have modifications. Excepting such as power house equipment where it is necessary to keep equipment in service regardless of cost, it is an open question as to which of these systems is the most desirable. A minimum overall maintenance cost is the criterion. Discussion of these two systems, particularly if backed up by cost data, would be very valuable. Then, too, data from various sources on cost of rewinding, cost of changing bearings, life of bearings, use of ball bearings or other anti-friction bearings, would be of much help to men responsible for the operation and maintenance of electrical and mechanical equipment.

Robert Drake, Electrical Engineer, McCormick Works, International Harvester Co., Chicago, Ill.: 1. My experience has been in large plants. Beside the routine inspection and maintenance of steam, water, electric, gas and other equipment, the really successful chief trains his organization, from motor inspectors up, to try to study out the cause of trouble and devise an alteration which will make recurrence impossible on the second breakdown of any one general type. If the gang foreman has constructive ideas he should come to the chief or his assistant with them. If he can't see a solution, but realizes that two or three delays have happened from the same cause, he should be trained to call attention to the fact and give someone else a chance to work out a solution.

Of course, no one can work out a solution for ordinary wear, burned fingers and the like, but these things should not cause delays for they can be taken care of by routine inspection at periods of about 60 per cent average life with complete replacement of worn parts at 60 per cent life to give a margin. This is cheaper than trying to get more life out of parts by "watching them and running them a little while longer." Such an idea of the chief's duties requires a testing and drafting force under his direction.

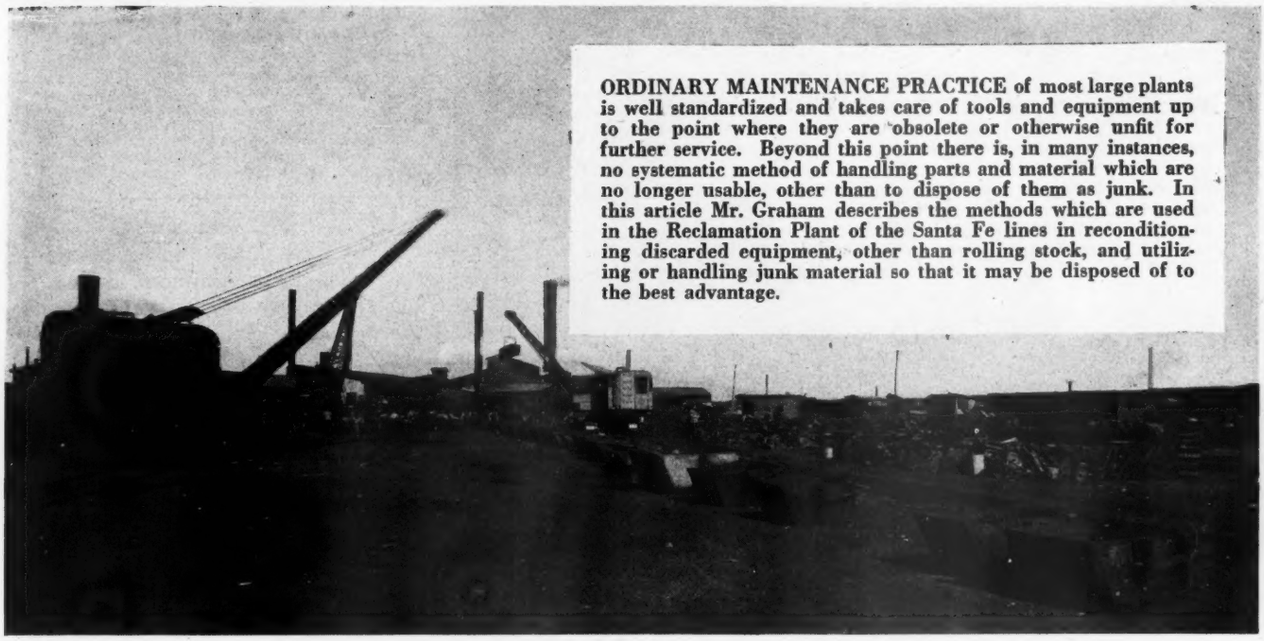
2. Division of work between Electrical Engineer and Master Mechanic can seldom be made according to a set schedule of duties except during the tenure of one man. The division varies with the ability, aptitude and previous experience of the incumbents. The Works Superintendent who alters this division to put the work in the "doubtful zone" onto the man best fitted to do it gets best results, assuming, of course, that a man who has risen to be Superintendent of a large works has enough diplomacy to do this without arousing jealousy. In dividing work it is always best to try to arrange it so that all the duties of any one foreman comes under one or the other head.

3. In my experience, maintenance and design of new construction and alterations come under one head. So far as maintenance foremen are concerned item (3) is answered under (2).

4. So few maintenance departments have a regular system of routine maintenance and inspection of miscellaneous equipment other than motors, starters, etc., that a description of how to build up such a system, how to carry it on and determine periods of inspection, and other details, might be of interest. This is not at all the most useful thing possible, I suppose, but it occurs to me because of the interest shown by plant engineers visiting our system.

5. The matter of greatest novelty which occurs to me is a long story. It refers to a practical method of testing a.c. motors without a wattmeter and in much shorter time.

F. A. Wiley, Electrical Engineer, South Chicago, Ill.: 1. The main duty of men in charge of maintenance and plant operation in a well-organized works is to keep the plant running, at all costs. Incidental to that is maintenance of equipment to reduce as much as possible unavoidable loss of production and to keep depreciation low. It is also their duty to maintain a stock of spare parts and spare apparatus to take care of any *(Continued on page 47)*



ORDINARY MAINTENANCE PRACTICE of most large plants is well standardized and takes care of tools and equipment up to the point where they are obsolete or otherwise unfit for further service. Beyond this point there is, in many instances, no systematic method of handling parts and material which are no longer usable, other than to dispose of them as junk. In this article Mr. Graham describes the methods which are used in the Reclamation Plant of the Santa Fe lines in reconditioning discarded equipment, other than rolling stock, and utilizing or handling junk material so that it may be disposed of to the best advantage.

A portion of the yard of the Reclamation Plant, where heavy iron and steel scrap is sorted and piled according to the classification of the material. The crane in the center is of the crawler type; it is driven by a gasoline engine and handles the sorted scrap. The two locomotive cranes are equipped with magnets and are used for loading and unloading cars.

Here Are Some Details of a

Reclamation Plant for Miscellaneous Equipment

Where Discarded and Broken-Down Equipment Is Rebuilt and Scrap Is Put Into Usable or Salable Form

By R. K. GRAHAM

General Superintendent, Reclamation Plant, The Atchison, Topeka and Santa Fe Railway Co., Corwith, Ill.

ORGANIZED maintenance work is essential in order to keep equipment in proper operating condition and secure from it the maximum possible service. A well-planned routine for handling equipment and material which have outlived their usefulness, in the ordinary sense of the term, and are considered as junk, will also pay good dividends as we have found by experience.

A very large amount of waste and scrap material comprising ferrous and non-ferrous metal scrap, worn or broken parts, car roofing and so on is derived in the course of a year from a railway system which operates 2,102 locomotives and 80,535 passenger and freight cars over 11,706 miles of track. In the shops of the Santa Fe line the work of keeping the rolling stock in first-class condition has always been well organized and executed, but until 14 years ago little or no attempt was made to reclaim material considered to be beyond repair. Much study showed that a good deal of material which we were selling as scrap could be reclaimed or worked into other usable forms at comparatively small cost. A portion of what is officially known as the Corwith yard, on the south side of Chicago, was finally set aside and an appropriation of $65,000 was made to provide buildings and working capital for a plant in which this work could be done. The original shop was a dismantled box car.

The reclamation plant at Corwith now covers twenty-six acres of ground and comprises two large, brick buildings and a number of large and small steel-frame buildings covered with sheet-iron.

In keeping with its object, the plant as a whole has been constructed almost entirely of junk or waste material. That is, the brick buildings were built of bricks which were picked up along the right-of-way in cleaning up the yards, or salvaged from other buildings or structures which have been altered or torn down. The mortar was made from the slaked lime which is a by-product of our acetylene-generating plant. When mixed with a small amount of cement this lime makes very satisfactory mortar and costs us practically nothing.

The steel framework of the buildings which house the various departments of the plant was fabricated from the beams and other structural shapes of old bridges and buildings. The sheet-iron roofing from wrecked or dismantled freight cars was used for the roofs and sides of the buildings. This, too, was scrap material which cost us practically nothing, but was entirely satisfactory for our purpose.

Again, the steel body of a discarded gasoline motor car was placed on a brick foundation and fitted up with showerbaths and lockers for the use of the rolling mill crew.

Old boiler tubes are flattened and cut into washers in this department.

A small set of rolls, not shown here, is used to flatten old locomotive boiler tubes after these have been cut into lengths suitable for handling. Two washers are thus cut at each stroke of the plungers of the presses shown here.

There are six main departments: valve shop; hose department; tinshop; blacksmith shop; bolt shop, and rolling mill. With the exception of the rolling mill the various departments are all equipped with lathes, drill presses, and other power tools which are needed for the processes to be described later on. In the rolling mill we have in operation a 9-in. mill, driven by a 300-hp. steam engine and a 12-in. mill driven by a 500-hp. engine. These mills will roll round material up to 2 in. diameter and flat stock up to 1 in. by 5 in. A good deal of miscellaneous cutting and welding is done both in the shops and in the yard by means of the oxy-acetylene torch. To supply these torches there is a central acetylene-generating station which has a rated capacity of 800 cu. ft. of gas per hr. From this station, both acetylene gas and oxygen are piped, at 9 oz. and 50 lb. pressure respectively, to the different shops and to numerous outlets in the yard, a total of thirty-six stations. The torches used for exterior work are connected to these outlets by lengths of rubber hose usually 100 ft. long. By this arrangement we are able to use acetylene at any desired location for cutting or welding without having to transport gas holders from place to place by means of hand trucks, as is often done.

For unloading cars and handling the large amount of scrap material which comes to this plant, there are available four type G, Industrial Works locomotive cranes and one Brownhoist crane. Three of these cranes are fitted with electro-magnets. Direct current for the magnets is obtained from a motor-generator set and conducted through an underground distribution system to a number of outlets fitted with Ralco, No. 9 power receptacles and located at intervals alongside the tracks. From the outlets current is conducted to the magnets on the cranes by a 200-ft. length of cable. In addition there is a gasoline-engine-driven, Industrial Works crawler-type crane which is used for piling sorted scrap and for other work of like nature around the yard.

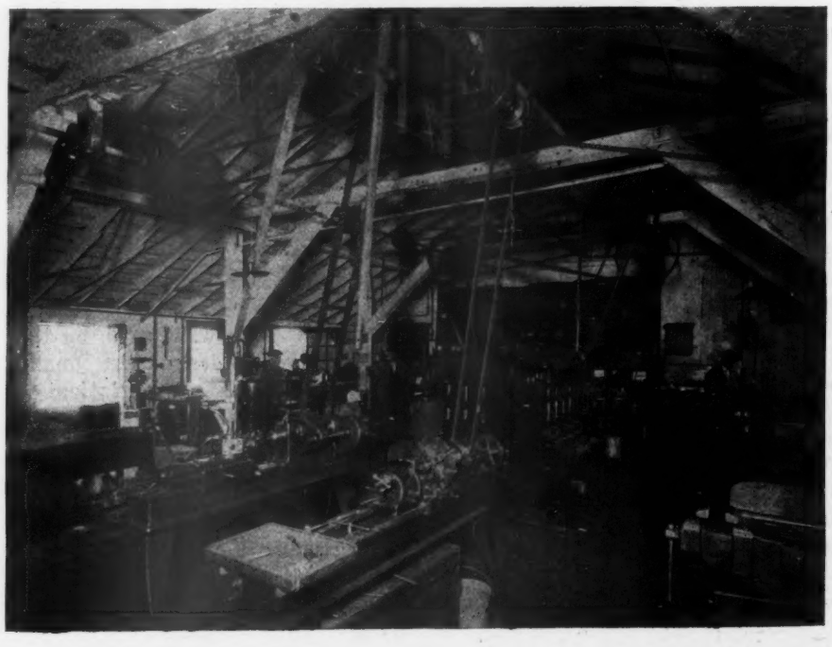
By the use of these cranes we feel that we have cut our material-handling costs to a minimum, considering the nature of the material and the operating conditions.

Scrap or waste material which we receive comes from the different division points of the entire Santa Fe system and is of the most varied nature, consisting as it does of all kinds of iron and steel, brass, copper and other scrap, discarded tools and equipment such as shovels, picks, track drills and lanterns, all kinds of air and steam valves, hose, paper, felt, glass, and so on, through the long list of equipment and material used by a large railway system. Although the material which we receive has been discarded as unusable in its present form, not all of it can be classified as junk: that is, as merely so many pounds of iron, brass and so on which will have to be remelted and worked into new products. A convenient and fairly accurate classification would be:

(1) Equipment and parts which can be repaired or otherwise treated to make them usable, at a reasonable cost.

(2) Material which can be worked into other forms at comparatively small cost.

(3) Material which is in such condition or of such nature that it can-



Air brake equipment and valves are reclaimed in this department.

All air brake equipment and valves which come in are taken apart and washed in the cleaning tank shown at the left. They are then carefully inspected, any worn or broken parts replaced, tested and sent to stock. The testing benches for air brake equipment were designed and built in the shop. The two valve-grinding machines shown in the right background were also designed and built here.

The tin shop turns old car roofing into pails, oil and waste cans and coal buckets.

The roofing on freight cars is made of about 24-gage galvanized iron. When cars are wrecked or dismantled the roofing is removed and sent to this department where it is cut and formed into oil cans, buckets, and other useful articles.

not readily be put into any useful form and therefore possesses only a scrap value.

It is our job to determine to which of these classes the various items and kinds of material belong and then treat them in such manner that a useful product can be made at a profit or, in the case of scrap material, properly prepare it so that it can be sold at the highest market price.

We receive and handle from ten to twenty carloads of miscellaneous discarded material a day, or about 8,000 tons a month.

All incoming material is weighed and the cars are then switched to the different unloading points, depending on the nature of the material which they contain. That is, brass and other non-ferrous scrap is unloaded at one place; heavy iron is unloaded at another place, and so on. After unloading, all of the material is carefully sorted out and the different classes or items placed by themselves. All of this is, of course, merely the first step in our work. The succeeding steps depend, as was stated before, on the nature of the material. Referring to the classification which was made previously, certain kinds of equipment and parts are worked over and put into usable condition. For example, trainmens' lanterns are thoroughly cleaned, bent or broken parts straightened or replaced, new globes put in if necessary, and finally sent back to stock just as good as new in every way. Shovels and forks are straightened and fitted with new handles. Tamping picks likewise are dressed and tempered and new handles put in, whenever necessary.

Steam and air valves are washed to remove all grease and dirt and are then taken apart and carefully inspected for wear and defects. Wheels, stems, packing nuts or other parts that may be broken or worn are replaced and the threads are retapped if necessary. The valves are then given a rigorous test and if they stand up satisfactorily they are sent to stock. In the same way ells, tees and other fittings are washed, the threads recut if necessary and after careful inspection sent to stock. Air brake equipment is thoroughly overhauled and inspected and tested with great care before it is returned to service.

In the case of wheelbarrows, frames are straightened, new wheels put in, if necessary, rivets tightened and any other needed repairs made. Track spikes are straightened by an air-driven hammer, similar to a small steam hammer, and then tumbled to remove all rust. Nuts are rethreaded. Bolts are straightened, if bent, and rethreaded. If the threaded portion is badly battered the bolt is cut to a shorter length and threaded. Truck and body bolsters which have cracked in service or been damaged in wrecks are welded with the oxy-acetylene torch, and after being annealed to relieve stresses, are returned to service. The list of equipment and parts which are repaired and returned to service covers a large number of items.

The second group in the classification covers material and parts which can be worked into other forms. As an example, old locomotive boiler tubes are cut into suitable lengths, flattened in a set of rolls and cut up into washers of various sizes. Likewise the heavy galvanized-iron roofing which is taken from wrecked or dismantled freight cars eventually goes to the tinshop where it is cleaned and formed into large oil cans, pails, coal buckets and so on.

Discarded pipe is cut into short lengths which are threaded to make nipples and couplings. Old car springs which are not of standard type are heated to a high temperature, uncoiled by pulling them in a specially designed machine and cut into short lengths, which are then made into nail pullers and light pinch bars.

A good deal of the round and flat wrought-iron material which comes to us is cut into short lengths and then made into bundles or fagots, heated to a welding temperature and rolled into round or flat bars in our rolling mill. From 60,000 lb. to 90,000 lb. are rolled a day. The round bars are made into car and engine forgings, bolts of various sizes, chains and so on. The flat material goes into coupling yokes and other forms. Car axles are now made of steel, but when any of the old iron axles come in we usually roll them down to a size which will meet some particular requirement. Journal brasses are heated to a sufficiently high temperature to melt out the babbitt which is cast into pigs and used again. If the brasses are not too badly worn they are sent to an outside concern for re-babbitting; otherwise they are sold as scrap metal.

Waste which comes under the third classification and possesses only a junk or scrap value comprises a wide variety of material, inasmuch as it includes everything which does not come under the other two classifications. In all cases, however, this material is carefully sorted and given any treatment which may be necessary in order to enable it to be sold to the best advantage. For example, large quantities of worn-out dry cells which have been used for open-circuit signal work are sent in to us. These are broken up and the zinc shells melted, cast into pigs and sold. The (*Continued on page 46*)

Some of the Ways

Equalizers Will Reduce Unbalance and Noise

In Induction Motors Together with Details on Employment of Ring-Type Connections for This Purpose

By A. C. ROE

Repair Superintendent, Detroit Service Department, Westinghouse Electric & Manufacturing Company

CONSIDERABLE NOISE in an induction motor is usually a signal of trouble which should be remedied. If it is caused by unbalanced mechanical or magnetic conditions it can often be reduced, in the case of a parallel connected winding, by putting on equalizer connections. Such connections have by far the best effect when employed with a winding of the short-jumper type. There is a number of the facts concerning equalizer connections which are worthy of study. Details and information on working out these connections are given in this article.

WHEN any induction motor is in operation there is always present a certain amount of noise, caused by windage, magnetism, current and so on. The noise caused by unfavorable conditions of magnetism and current can, however, in some cases be reduced by using the proper type of connections and employing equalizers. The proper connections and equalizers are discussed in the following paragraphs of this article.

Magnetic noise is due, for the most part, to a pulsating field of high frequency which causes the laminations to vibrate. The amount of noise due to this cause depends upon the design of the machine. It may be lessened by using the correct proportion of rotor slots as compared with stator slots, by skewing the rotor slots, by using magnetic wedges and in other ways.

The current noise is due to unequal air gap, or any other mechanical, magnetic or electrical dissymmetry. Electrical symmetry can be secured by employing a well-balanced winding with equal coil groupings. This will tend to reduce noises caused by current. Often, however, there are other conditions present which cause an unbalance, even though the winding itself is perfectly balanced. The most common of these is an uneven air gap. Under such a condition the current noise can be reduced to a certain extent in parallel windings by the use of equalizer connections. In a series winding, of course, equalizer connections are not possible, and therefore cannot be employed to reduce noise. An equalizer connection may be applied to any parallel connected windings, but its ability to reduce noise depends upon the particular kind of winding. It will be greatest for a winding with short jumpers connected top-to-top. It will also have some corrective effects on a top-to-bottom type of connection (long jumper). On the right-and-left type of top-to-top connection an equalizer will be of practically no value. The effect of an equalizer on these different types of winding is discussed later, but first it may be well to discuss the effect of the unbalanced condition, and the reasons for the unbalance.

Suppose, for instance, we have an induction motor with uneven air gap due to worn bearings. When the rotor of the motor is out of center, approaching closer to one pole than the others, the air gap of the pole it approaches is decreased while the air gap of the pole directly opposite is increased. Increasing the air gap increases the reluctance, which means that with the same magnetizing current flowing, the total magnetic flux will be decreased. Likewise, at the pole where the air gap is decreased, the magnetic flux is increased. Where the magnetism has increased this will increase the pull on the rotor and tend to pull it still further out of line. As the magnetic flux on the opposite pole has been weakened the pull on the rotor on that side has also been weakened. Then, what is needed to correct this abnormal condition is some means of increasing the magnetic strength of the weak pole and decreasing the magnetism of the strong pole. Now this may be done automatically if proper provisions are made for a path for circulating corrective current. This is the object of the equalizer connection.

The counter-electromotive force and the resistance of a coil or group of coils limits the current flowing through this part of the winding. The current is forced through the group ordinarily by means of the voltage impressed upon the motor. Now in a parallel winding, if different counter-electromotive forces are set up in two parallel paths, a circulating current will flow around between these two paths. In order to make use of this principle for correction purposes, this circulating current must flow in the weak pole in the same direction as the main motor current, thus strengthening this weak pole. Conversely, the circulating current in the strong pole must oppose the main motor current, thus weakening the strong pole. The problem is to apply the different counter-electromotive forces in such a way that the circulating currents will flow in the correct direction through the different portions of the winding.

It may be well to explain here how this circulating current is in phase with the main current, and may thus be employed to strengthen it or reduce it. In any induction motor the magnetizing current lags 90 deg. behind the applied line voltage. This magnetizing current sets up a magnetic field that is in line with this current. In turn, this field induces the counter-electromotive force in the winding, this counter-electromotive force being directly opposite to, or 180 deg. behind, the applied line voltage. Then, when the counter-electromotive force of one leg of a parallel circuit becomes less than that of the other leg, a current will flow which lags 90 deg. behind the counter-electromotive force.

This current is in phase with the main magnetizing current, and is in a position to add to or subtract from this main current.

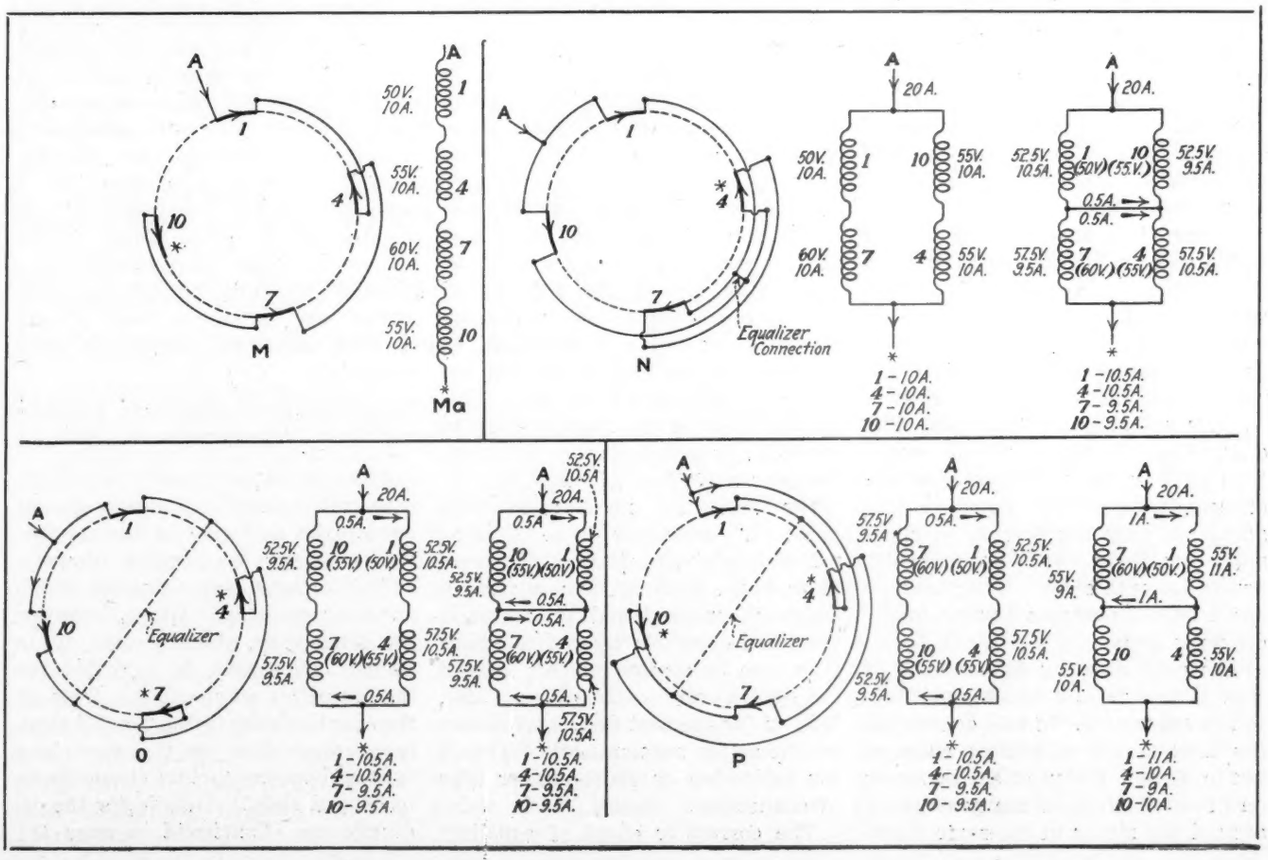
To explain this by a concrete example, suppose the diagrams shown in Fig. 1, represent a motor with worn bearings, which allows the rotor to drop downward. These diagrams show only one phase of a four-pole motor, the other phases being omitted in order to simplify the explanation. Suppose the rotor has dropped so that it is nearer to group 7 and further from group 1, while the distance from groups 4 and 10 remains practically the same as before. The connection shown in drawing *M* is for a 220-volt motor. If the motor windings were perfectly balanced and the rotor were in the center of the stator, the counter-electromotive force on each of the four groups would be about 55 volts. With the worn bearings, however, the counter-electromotive forces in the different groups are as shown in the small diagram *Ma* at the right of *M*. The voltages indicated in these small diagrams for all of the figures in these drawings are counter-electromotive forces. Then the voltage in group 1 is 50 volts; group 4, 55 volts; group 7, 60 volts, and group 10, 55 volts. If the motor draws 10 amp. the same current is flowing through each of the groups shown in this drawing because they are in series and, therefore, no corrective action can be obtained by equalizer connections.

Next, take the two-parallel connection as shown in *N*. This winding has top-to-bottom or long-jumper connections. As shown in the small diagram next to drawing *N*, there is no corrective action when no equalizer is used. Furthermore, when the equalizer is employed as shown in the right-hand drawing, there is some corrective action, but this is not very great. It may be explained that the figures in parentheses inside of this small diagram represent the counter-electromotive forces that would be generated if the groups were not connected in parallel. However, when they are connected in parallel a circulating current flows and the counter-electromotive forces change, as shown by the notations on the outside of the small diagram. We show in this diagram then that between groups 1 and 10 a circulating current of 0.5 amp. flows. This increases the current in group 1, which is desirable; but at the same time it reduces the current in group 10, which is not desired. Likewise, a circulating current in groups 7 and 4 reduces the current in group 7, which is desirable; but it increases the current in group 4, which is undesirable. Therefore, the corrective effect from this arrangement is not entirely satisfactory.

Next may be considered the right-and-left type of top-to-top connection, as shown in drawing *O*. This

Fig. 1—Advantages of equalizer connections on various types of windings.

Each diagram, *M*, *N*, *O* and *P*, represents one phase of a four-pole motor. The small diagrams at the right of the circular diagrams show the connections schematically. It is assumed that the bearings of the motor have worn allowing the rotor to drop so that the air gap is decreased at group 7 and increased at group 1. Consequently, the counter-electromotive force in group 7 is increased from normal while that at group 1 is decreased. The counter emf. of each group is shown by the figures representing voltage, such as "55V." The letter "A" where it appears represents amperes. In drawings *N*, *O* and *P*, the counter emf. is shown inside the small drawings and enclosed in parentheses as "(50 V.)." This notation denotes the counter emf. which would be generated if there were no circulating currents flowing. But the voltage on each side of the parallel paths is equalized by circulating current. This voltage is represented by the figures outside the diagrams. The drawings at *M* show a series connection. No equalizer can be used on this. At *N* is a long-jumper, two-parallel connection. The equalizer has some corrective action. At *O* is a right-and-left, two-parallel connection. This winding has some corrective action without the equalizer but the equalizer does not increase it. At *P* is the best connection for corrective action. This is a short-jumper (top-to-top) connection. The equalizer gives the maximum corrective effect in this case.



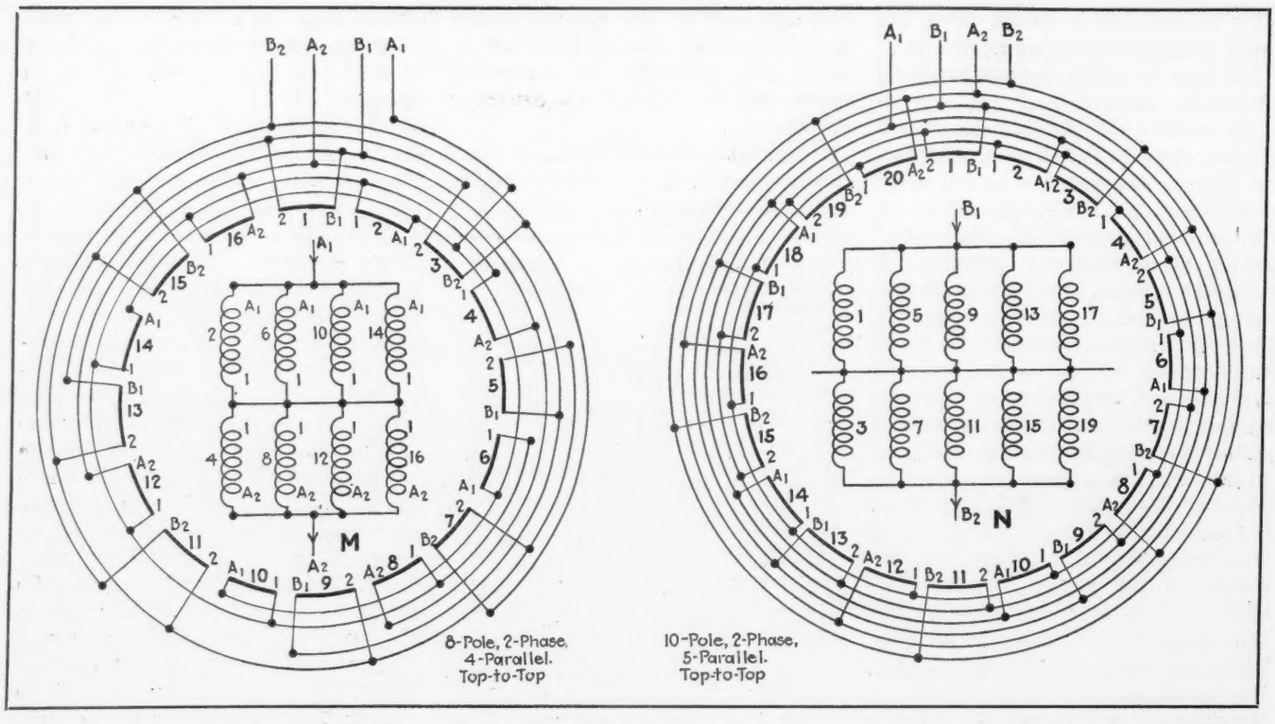


Fig. 2—Examples of long jumpers and ring connections.

At *M* the connections are by means of long jumpers to which are tapped the various groups. One long jumper, for instance, connects all the groups of one phase together. In place of this the ordinary connection would use four short jumpers located respectively between coils 2 and 4, 6 and 8, 10 and 12, and 14 and 16. This long jumper also acts as an equalizer. At *N* all connections are made to rings, of which there are six. Each of the two innermost rings in the diagram takes the place of five jumpers. In addition the rings act as equalizers.

likewise, is a two-parallel connection. When no equalizer is employed, as shown in the small figure directly at the right of drawing *O*, the original counter-electromotive force of groups 10 and 7 is greater than that of groups 1 and 4, and consequently a circulating current flows. This circulating current of 0.5 amp. adds to the main current in groups 1 and 4, and subtracts from the main current in groups 7 and 10. The result is the same as for the equalizer connection in drawing *N*. The current in group 1 is increased to 10.5 amp., which is desirable; but the current in group 4 is likewise increased to 10.5 amp. which is not desirable. The current in group 7 is decreased to 9.5 amp., which is desirable; but the current in group 10 is at the same time decreased to 9.5 amp., which is not desirable. Connecting an equalizer across, as shown in the right-hand small figure with drawing *O*, does not alter the positions. The circulating currents which would tend to flow through this equalizer connection are both equal to 0.5 amp., but they are flowing in opposite directions, and consequently neutralize each other. They have no effect on the currents flowing in the different groups.

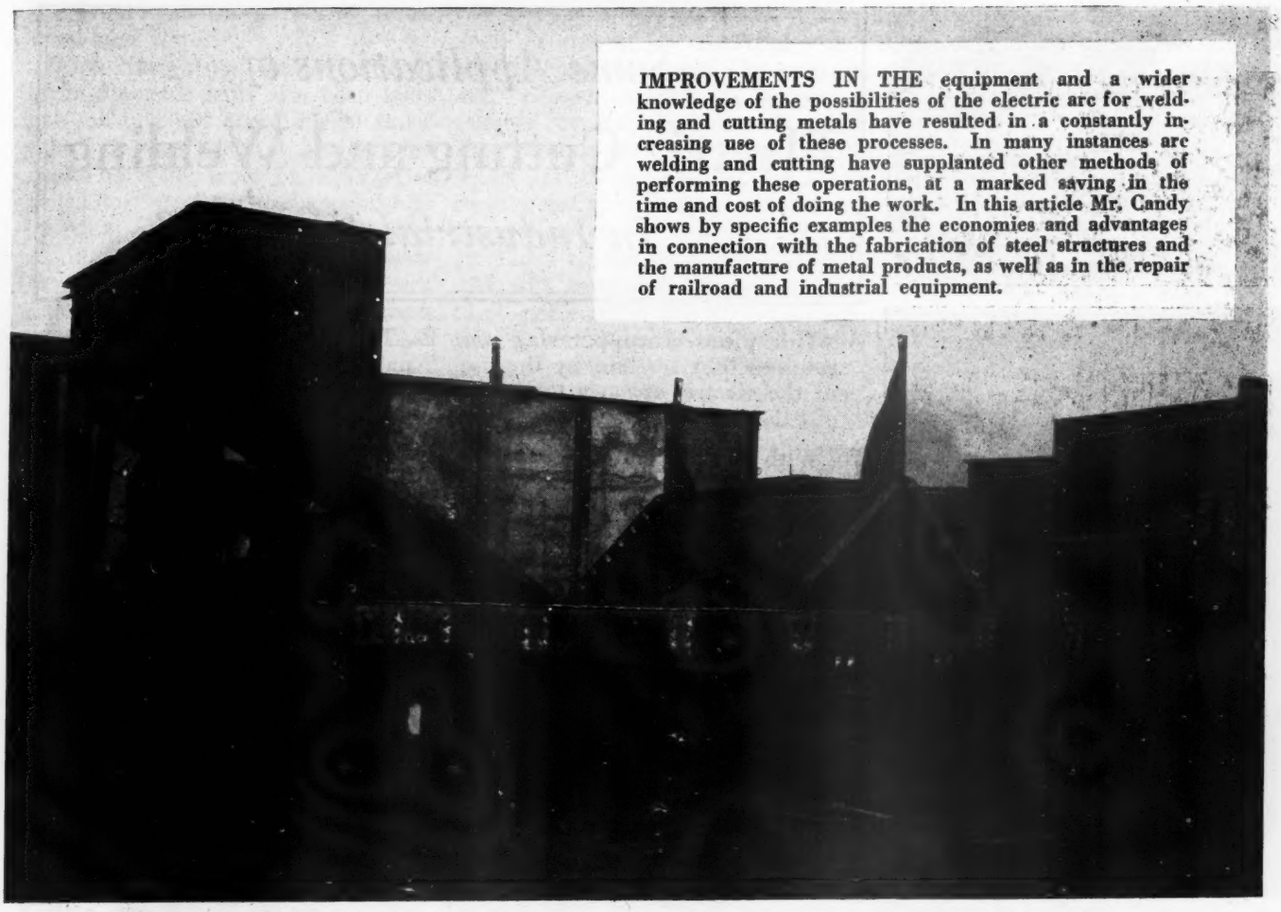
The next drawing shown in *P* of Fig. 1, illustrates a two-parallel top-to-top connection. In this connection the first series of groups ends on group 4, and the next series starts on group 7 which is the next group around the stator in the same direction. This is called connecting in parallel "on the half." Without any equalizer connection there is some corrective action as shown in the small figure directly at the right of *P*. This is the same as was obtained in the two previous cases, at *N* and *O*. However, by putting on an equalizer—as shown in the drawing at the extreme right—the maximum corrective effects are obtained. In this case the circulating current between groups 1 and 7 is 1 amp. This current adds to the main current in group 1, increasing it to 11 amp., which is desirable. Likewise, it subtracts from the main current in group 7, decreasing it to 9 amp., which also is to be desired. Furthermore, there is no circulating current between groups 4 and 10, which is the third desirable condition. Thus it is seen by comparing this type of connection with the others, that it is by far the best for securing corrective action automatically. This is the top-to-top or short-jumper type of connection.

The corrective effect of equalizer connections with a large number of parallel paths is very good. For instance, in a machine connected as in drawing *N* of Fig. 2, a complete group of coils could be cut out without any apparent effect on the operation of the motor. There might be some unbalance in the line current, but the motor would not overheat.

Where windings with unequal groups of coils are used, care should be taken that equalizers connect in parallel only such groups as have the same number of coils. As many equalizer connections as possible should be put on a winding. In a parallel winding in which three groups are in series, there should be two equalizer connections; in a parallel winding in which four groups are in series, there should be three equalizer connections; and so on.

Ring Type of Jumper Uses Lighter Conductor

The conductors used for these equalizer connections usually do not need to be as heavy as the conductors used for the regular jumpers, as they usually carry currents which are not very large. Often, however, the same wire which is used for a jumper connection is extended for the equalizer connection. This is true particularly in the case of ring-type connections or the very long type of jumpers such as those shown in Figs. 2 and 3. Details for the ordinary use (*Continued on page 45*)



IMPROVEMENTS IN THE equipment and a wider knowledge of the possibilities of the electric arc for welding and cutting metals have resulted in a constantly increasing use of these processes. In many instances arc welding and cutting have supplanted other methods of performing these operations, at a marked saving in the time and cost of doing the work. In this article Mr. Candy shows by specific examples the economies and advantages in connection with the fabrication of steel structures and the manufacture of metal products, as well as in the repair of railroad and industrial equipment.

The rivets in this steel freight car were cut by the electric arc at a cost of a little over one cent apiece. The cost of cutting these rivets by other methods will average between 2¼ and 2½ cents apiece.

Here Are Some Examples of

Arc Welding and Cutting Economies

That Have Been Made by Using These Processes for New and Repair Work

By A. M. CANDY

General Engineering Department, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

PROCESSES of arc welding and cutting were, until recent years, very much limited in application and found their widest use in railroad shops. Along with the improvement in welding equipment and more information regarding the application of the electric arc for cutting and welding a much broader field is, however, being opened up in various industries where this tool is coming into use in manufacturing operations. Before the management of any organization can determine the advisability of installing the electrical equipment needed for this work it is necessary not only to learn the cost of this equipment, but also the savings to be expected by replacing present methods and processes with the arc processes. The information given below will be of interest in this connection.

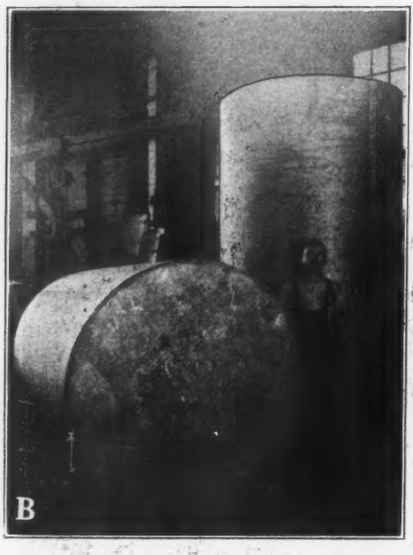
An example of the speeding-up of manufacturing processes by the use of arc welding is found at a certain boiler and tank works in West Virginia, which makes, among other classes of work, tanks 8½ ft. in diameter and 10 ft. high. The head and bottom are of 5/16-in. steel and the shell is of 3/16-in steel. The shell is composed of four plates assembled with rivets on 2-ft. centers. By the arc process one operator can now weld the shell plating and heads to the shell, using a single fillet along the lapped joints, in eleven hours. To rivet one of these tanks formerly required the labor of six men for eight hours.

Near Vallecita, California, a welding company has recently completed a 100-ft. tower constructed of spiral strips, which incloses a spiral stairway. In all there is a total of 7,200 welded joints. The engineer of this job estimates that the weight of a similar tower of the usual riveted construction would be about 13 tons, compared with an actual weight of a little over 3 tons for the steel used in the welded construction. The cost of the completely welded tower was $3,000 as against $12,000 which was

Some Applications of

Electric Cutting and Welding

In Industrial Work



A—This piece of copper slag was cut into four sections by the use of the electric arc at a total cost of $15.40.

B—With the arc one operator can weld one of these tanks in eleven hours. It takes six men eight hours to rivet a tank.

C—This building, which is 200 ft. long and 75 ft. wide, was assembled by arc welding for less than it would have cost for the usual riveted construction employed in such work.

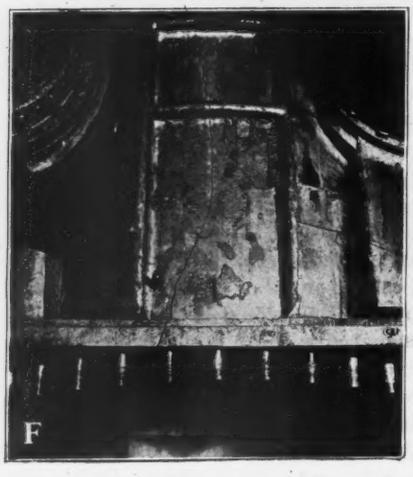
D—A broken mold for making automobile tires, before welding. These molds cost from $200 to $500 apiece.

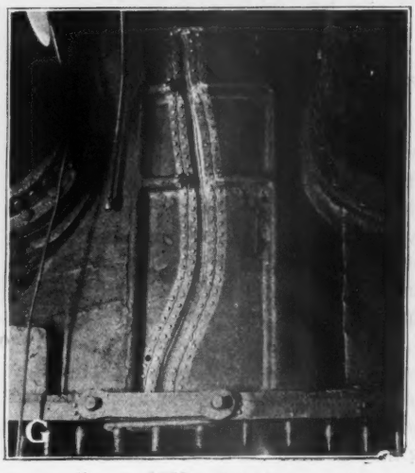
E—The same mold after it was repaired by arc welding. The repairs cost less than $70, a small part of the cost of a new mold.

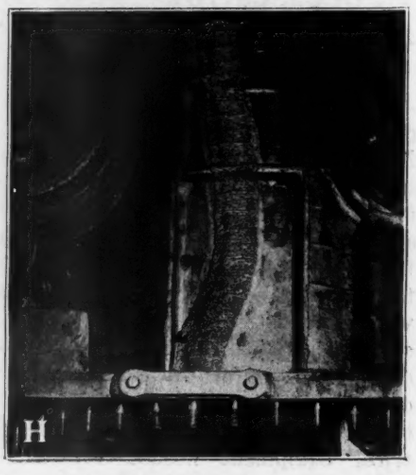
F—A 5-ft. crack in the cylinder of a 1500-hp., vertical blowing engine was repaired by arc welding for $737.20.

G—A V-shape groove was cut along the line of the crack and studs put in along the sides, preparatory to arc welding.

H—This shows the weld which was finished in 41 days and cost less than $750. A new cylinder would have cost $12,000 and could not have been obtained in less than nine months.







the lowest bid for a riveted structural steel tower.

Pipe lines using welded pipe of large diameter have also been laid; one job involved about 30,000 ft. of pipe. It was found that the pipe could be made from plate material rolled to the required diameter and length and then arc welded, thus producing it at a cost appreciably below the market price of the same size pipe. The sections of the pipe were welded together, end to end. This pipe line was used for dredging and showed a life several times as long as that of so-called standard dredge pipe.

In 1922 a 3,000,000 cu. ft. gas holder, 200 ft. in diameter and 100 ft. high above street level, was entirely constructed by arc welding by the Metropolitan Gas Company, of Melbourne, Australia. This holder comprises three telescopic lifts each 30 ft. high. When the job was completed only six pinhole leaks were found in the entire envelope, which weighs 600 tons and contains over 20 miles of lap-welded joints. The engineers of this company were so well satisfied with the job that a still larger holder was later constructed, involving four telescopic lifts each 30 ft.

As another instance of the possibilities of using electric welding in construction work, one of the accompanying illustrations shows a factory building, 200 ft. long by 70 ft. wide, the structural steel work of which was entirely assembled by arc welding at an appreciable saving over riveted construction.

In the field of repair work, the savings which are made by arc welding in place of other methods are sometimes very large. For example, one of the illustrations shows a broken locomotive cylinder, the cylinder ready for welding, and the completed job. The saving, compared with the cost of installing a new cylinder, is indicated by the following data:

Cost of welding cylinder (labor and material)	$ 125.00
Time out of service—5 days	100.00
Total	$ 225.00
Cost of new cylinder ready for locomotive	$1,000.00
Labor to replace it	150.00
Locomotive out of service 18 days	360.00
Total	$1,510.00
Credit for scrap value of cylinder	177.00
Total	$1,333.00
Cost of welding cylinder	225.00
Total saving	$1,108.00

Forge shops can save appreciable sums of money by repairing worn and chipped dies with the electric arc. Elsewhere there is shown a number of blanking dies for eye rods, bolt heads and other parts which have been reclaimed for service at a cost of from $5 to $10 apiece, whereas the cost of new dies will run from $35 to $50 each. The welded dies will develop from 50 per cent to 80 per cent of the life of a new die. In many cases however the ability to repair a die will eliminate the long delay required for obtaining a new die and therefore the saving in production time will be several times the cost of welding.

Another illustration shows an automobile tire mold before and after repair by the arc process. These molds cost from $200 to $500 apiece, depending upon the size and particular tread design which is cut in by hand. The cost of repairing this die by welding was as follows:

Preparation of casting	$14.40
Stud bolts	3.00
Steel to replace broken lugs	7.75
Welder's time	36.00
Welding wire	3.20
Electric power	5.00
Total	$69.35

Again, very large savings are being made in steel mills on many classes of equipment. In one instance the cylinder of a vertical blower engine, 80-in. bore, 60-in. stroke, 1,500 hp., which was cracked for a distance of 5 ft. on one side and 3½ ft. on the other, was repaired by welding. The total cost of repairing the cylinder, including reboring, was $737.20, compared with $12,000 for a new cylinder. The total time required for repairs was 327 hours, against 9 months required for delivery of a new cylinder, ready for installation.

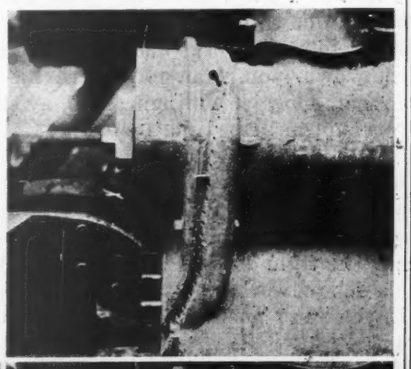
Again, mill spindles are being built up by the arc process in many plants. The larger spindles will cost several hundred dollars each. Rod mill spindles, costing $145 each, can be reclaimed for $25 to $30 apiece and the welded spindles usually give longer service than the original castings. It is not unusual to build up by welding spindles which are so badly worn that the cost of welding will be equal to the cost of a new spindle. The mill operators justify this, however, by the fact that the ability of the old spindle to withstand the service is known, whereas if a new spindle is installed it may fail prematurely.

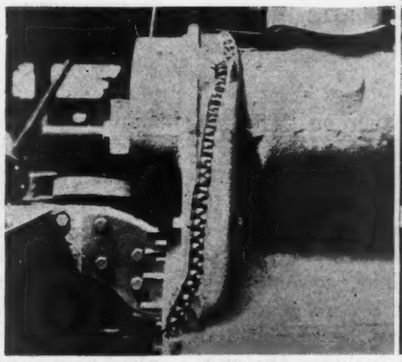
Steam railroad shops and electric railway shops have saved their companies thousands of dollars a year through the use of arc welding in the maintenance of rolling stock and equipment, as is shown by a few typical items given in an accompanying table.

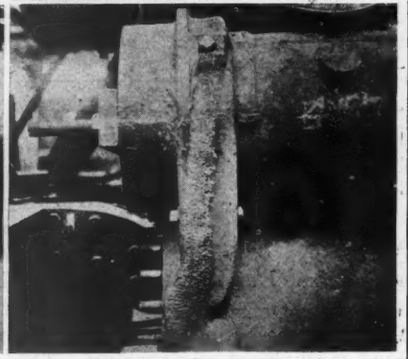
In the field of metal cutting, the arc process (*Continued on page 45*)

A saving of $1,108 was made by welding this locomotive cylinder instead of buying a new one.

This shows three steps in the process of welding a cracked locomotive cylinder by the electric arc. In the upper illustration a V-shape groove has been cut along the line of the crack and a number of small holes drilled and tapped to receive steel studs. The illustration at the left shows these studs in place and the cylinder made ready for welding. The finished weld is shown at the right. The studs are used to obtain a firmer union between the old metal and that deposited by welding and thus make a stronger weld.







INDUSTRIAL ENGINEER

Devoted to the Maintenance and Operation of Electrical and Associated Mechanical Systems in Mills and Factories

DANIEL H. BRAYMER
Editorial Director

Assisted by

G. A. VAN BRUNT F. E. GOODING A. J. WHITCOMB

Chicago, January, 1924

A Viewpoint on Passing the Buck

IF WE ALL had the same likes and dislikes combined with equal ability and were 100 per cent perfect, this would be a queer sort of a world. But in the plan of our Creator we are all different in some one, two or more ways and it's good that it is so. Too often we do not know this nor realize the way these differences can be made use of in life's work, its responsibilities and its rewards.

Perhaps the plainest indication of this weakness in our thinking is the attitude, shown so frequently, that failure to do the thing that seems perfectly evident is due to the fault of the other fellow. And when we fall short the suggestion that first comes to mind is that, "I have done my part but the other fellow has lain down on the job." Perhaps he did, but if that other fellow's work was in any way associated with your own, you, yourself, share his failure when you do not show a willingness to avoid the failure that you happen to be able to foresee.

In a word, we are fellow workers in a great job, each doing a part, and the completed work will be pleasing and satisfactory to the degree that helpful co-operation is reflected by all. In short, then, no man has the right to pass the buck or ride on the ability of his fellow worker. It's a simple case of push or pull! If you can't push or pull, then get out of the way, but do that in recognition of the one who is at your heels and from whom you can learn something so that you will known when and how to push or pull next time.

Importance of Maintenance in Production

IN a paper on "The Mechanical Engineering of Management in the Metal-Working Trades," at the recent annual meeting of the American Society of Mechanical Engineers, Robert T. Kent, a well-known consulting engineer, pointed out that before good management can become effective, it must be preceded by good mechanical engineering. This includes the engineering of the product as well as of the plant and equipment. All this work should be preliminary to time studies, schedules and other managerial functions. In discussing the engineering of the plant equipment—machinery, plant layout, and material-handling devices—Mr. Kent emphasized the importance of good maintenance as follows:

> The question of power bears an intimate relation to production and management. This subject means more than the power plant; it means power actually available at the cutting tools. This takes us back through the machine gearing, the belts and countershafts, lineshafts and motors to the generators, engines and boilers * * * *.
>
> Proper maintenance not only reveals the causes of lack of power, but frequently prevents these causes from occurring. It may, therefore, be proper to list a few of the causes of inadequate power that have come under the author's observation, and which were removed by the establishment of a proper routine of maintenance. These included lack of tension in belts; belts too light for the machinery; excessive lineshaft friction, remedied by the installation of roller bearings; machine gearing too light for the duty imposed on it; variations in voltage, due to improper power plant operation; the driving from the same lineshaft of machines requiring a relatively constant amount of power and of machines taking heavy drafts of power at more or less frequent intervals * * * *.
>
> Proper and adequate inspection and maintenance of the power-generating and transmission appliances will frequently postpone to the distant future the purchase of additional boilers, turbines, and generators, even in cases where these apparently are badly needed.
>
> There is another feature of maintenance which should not pass unnoticed. Nothing upsets production so much as equipment failures. The cost of a belt breaking during working hours far exceeds the cost of repairs to the belt. It includes the cost of idle equipment, of the wages of idle mechanics while repairs are being made and, perhaps most important of all, the loss of production and the disruption of the shop schedule. The same remarks apply to all other equipment failures. It is worthy of note that equipment failures seldom occur where regular maintenance is a part of the shop routine. Maintenance provides for preventive repairs, and insures against breakdowns. It may be set down almost as an axiom that shop maintenance is one of the fundamentals of good shop management.

Good production, backed by effective management should see that all the preliminary details of operation and its continuance are provided for before it can effectively produce through the managerial functions of planning, scheduling and controlling of work. A "key" machine down for repairs can throw a big monkey wrench into the gears driving production. This statement is as true in other lines of industry as in the metal-working trade.

Does Your Plant Layout Always Tell the Whole Truth

AN INSTALLATION Engineer for a large company recently called attention to several instances where failure of the engineering department to keep their layouts up to date, in works in which he was erecting equipment, was the cause of much delay and expense. In one case, a 24-in. water main, which was not shown on any plan and whose existence had been forgotten, was discovered after most of the required excavating had been done. Inasmuch as this pipe interfered with the new equipment and could not be moved the latter had to be redesigned to meet the new conditions.

In another instance excavation uncovered a large number of underground ducts containing cables and water and air lines. These, too, were not shown on the plant layout and had been forgotten. Again, redesign-

ing of the new installation was necessary, at a cost of several hundred dollars and nearly a month's delay in getting the equipment installed.

Instances of this sort are by no means as rare as might be supposed, but they represent a state of affairs for which there is little real excuse. It is true that in most works of any size extensions or changes are constantly being made, but that is all the more reason why these changes should be promptly and accurately recorded on the plant layout. Unless all power circuits, water, gas and other lines are clearly shown serious delays may be occasioned by the necessity of tracing out these arteries after failure has deprived the works of the vital service which they render.

An unreliable guide is worse than no guide at all, because it may not only give a false sense of security, but the information which it supplies may be misleading, and therefore dangerous.

How to Get the Job You Want

WHY WILL an outside firm pay you an increase in salary when they need you? Why won't your own firm pay you more to stay? One of them knows your present ability, the other merely knows you in a casual way. The outside firm, however, will not be fooled very long unless you produce the goods that it requires. Have you ever stopped to consider that your own firm might pay you more if you were delivering what the outside firm expects to get from you? Perhaps your own firm has you catalogued for one job and you are simply fulfilling the duties of that job and no more.

The shop foreman, to become an assistant superintendent, must know how to do the construction foreman's work, for how else can be hope to boss the construction foreman if he is unfamiliar with the work that the latter does? Likewise the shop foreman must know how to do a great deal of the superintendent's work, for he cannot be an assistant superintendent and expect the superintendent to do his work for him. In the final analysis the man who gets the increase in pay is the man who is in line for promotion and he is the one who not only does his work well, but can also do the work of his associates and has made his superior feel that he can do the boss's work, too, when the opportunity or emergency comes up.

How to convince a superior that such is the case calls for diplomacy in addition to ability. It can be done by displaying initiative on your own job, by doing your own job better than it was done before and by originating methods for doing it. These things show the boss that you can use your head to think as well as carry your hat.

Initiative, originality and resourcefulness can be developed in two ways—by reading and studying the books and methods of men who have done the things you are striving to do, and by contact with the men who are now doing the things that you want to do. But all of this study and contact is of no avail unless you are able to apply it to your own job for it is the application of what you know that lifts you up the ladder of success.

The requirements of success are the same in the plant across the street as in your own plant; so why not stay at home and get the job you want?

The New Year and Its Opportunities

ACCORDING to our method of measuring time, another twelve months of accomplishment is behind us and a new twelve months' period of opportunity is ahead. Hardly anyone who takes himself seriously is quite satisfied with what he has done and at this time of the year, when the deficiencies of 1923 go with the work of that period, it's natural and right that a fresh start should be made with all the confidence in the world that new things can be accomplished and placed to your credit in 1924 through proper and diligent application of the experience of honest effort already accumulated.

It is important that the viewpoint be right and the aim set high in this mental inventory of one's capabilities and in this connection we believe there is a whole lot of practical inspiration in those lines of Edgar A. Guest which go as follows:

The many will follow the beaten track
With guideposts on the way,
They live and have lived for ages back
With a chart for every day.
Someone has told them it's safe to go
On the road he has traveled o'er,
And all that they ever strive to know
Are the things that were known before.

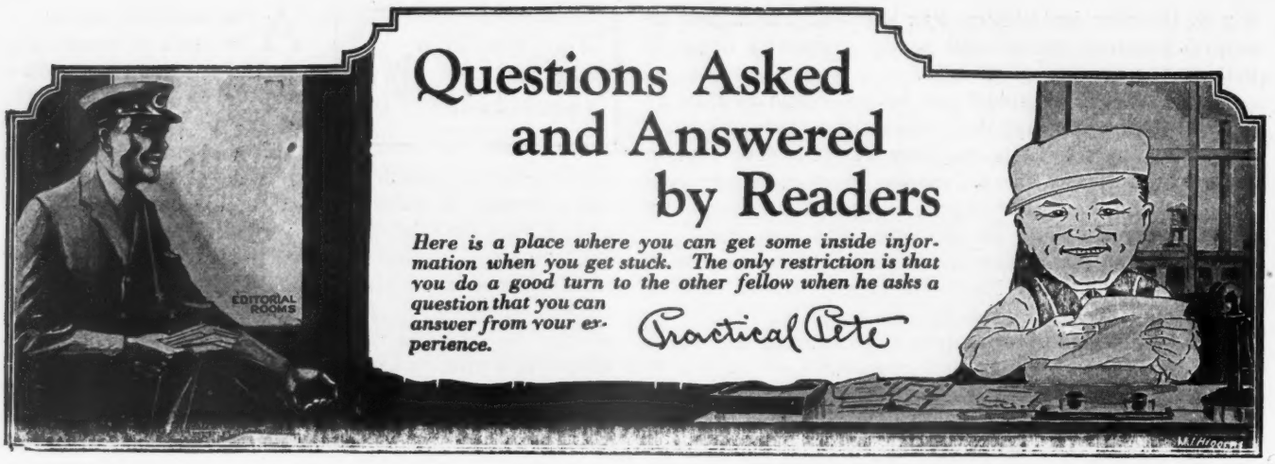
The things that haven't been done before
Are the tasks worth while today;
Are you one of the flock that follows, or
Are you one that shall lead the way?
Are you one of the timid souls that quail
At the jeers of a doubting crew,
Or dare you, whether you win or fail,
Strike out for a goal that's new?

Economists and business men have already expressed a confidence in the stability of business ahead. No threatening clouds are yet on the horizon. So with such a bright and cheerful beginning, we wish you, one and all, a wider vision and happiness and prosperity during 1924, in a fuller measure than you have ever enjoyed before.

Why Power Service Equipment Goes Wrong

THOSE who have been following the series of articles which have appeared in the INDUSTRIAL ENGINEER, covering power transmission equipment such as gears, pulleys, belts, silent chains, flexible couplings, clutches and cutoff couplings, have probably noticed that practically the same statements in regard to operating conditions have been made in connection with each item. Particular emphasis has been laid in each case on three primary essentials to good service —proper capacity for the operating conditions, correct installation, and the necessary attention after installation.

Where power transmission equipment has given trouble the cause can almost always be traced directly back to an utter disregard of one or more—frequently all three—of these primary considerations. Many pieces of equipment carry a black reputation in some plants when the real responsibility rests, not on the equipment, but upon the man whose job it is to get the most out of it under conditions that will make this possible. For carelessness and negligence there is no good excuse.



Questions Asked and Answered by Readers

Here is a place where you can get some inside information when you get stuck. The only restriction is that you do a good turn to the other fellow when he asks a question that you can answer from your experience.

Practical Pete

Who Can Answer These?

Putting Tires on Wheels of Bandsaws—Will someone be kind enough to tell me what is the best method of putting tires on the wheels of bandsaws? I shall appreciate this information very much.
Chicago, Ill. J. W. C.

* * * *

Winding Data for 15-hp. Motor—Will some reader of INDUSTRIAL ENGINEER please show me how to figure the winding for a motor in which the outside diameter of the stator lamination is 17 in., and the inside bore is 12½ in. The axial length of the core is 4½ in. The primary slots are 1¼ in. deep and the slot width is 7/16 inches. The tooth width is ¼ in., and there are seventy-two slots. I want this motor to have six poles and develop 15 hp.
Fayetteville, N. C. E. A. K.

* * * *

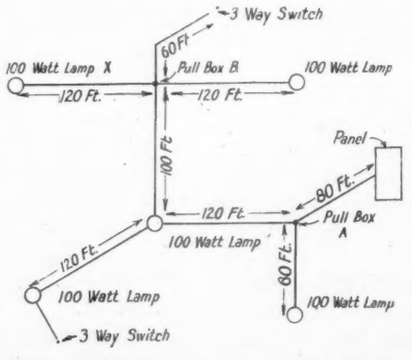
Transformer and Balancer Coil Connections—In our plant we are operating one 50-hp., one 30-hp., two 5-hp., and two 2½-hp. three-phase, 60-cycle, induction motors. The lighting load, single phase, amounts to about 10 kw. I wish some reader of INDUSTRIAL ENGINEER would give me a diagram showing how to connect three 5-kva. single-phase transformers and balancer coils to obtain 110-volt single-phase current for lighting from the 220-volt, three-phase line from our alternator. Will you also show me how to cut in on the power company's transformer in case our machine should get out of order, and how to cut out their meters and transformers both at the same time when our machine is ready to be put in service again.
Detroit, Mich. O. C. H.

* * * *

Trouble with Large Generator—I wish some reader would answer the following questions: (1) We have a 150-kw. Westinghouse generator that will not compound when the load is applied. That is, when the load is on the voltage drops too low. Formerly this generator carried the load satisfactorily but during the past year we have been having trouble with it. What is the cause? (2) Should it be possible to ground together that is, connect the ground leads, of two generators, one of which supplies current to motors driving machine tools, while the other operates a motor which is connected to a pump? When we ground the generators together the breakers open and we have trouble, which disappears when the grounds are disconnected. What is the explanation of this? (3) Can two motor-generator sets be operated in parallel when their voltages are the same but they are not of the same size and do not run at the same speed? One set is rated at 200 kw. and runs at 1200 r. p. m., while the other set is rated at 150 kw. and runs at 900 r. p. m. (4) We have two generators, one of which is in a motor-generator set running at 900 r. p. m., while the other is steam-driven and operates at 225 r. p. m. The voltages of these generators are the same. Can they be operated in parallel?
Beaverdale, Pa. M. A. L.

* * * *

Why Do the Fuses on this Circuit Blow?—I recently wired a large concrete warehouse and should like to know why the 10-amp. fuses on the watchman's lighting circuit blow after the current has been on for a few hours. As shown in the diagram below, this circuit is controlled by two 3-way switches. No. 8 wire in 1-in. conduit is used throughout for this 110-volt a. c. circuit which contains five 100-watt lamps. From the panel to the first pull box, *A*, a circuit of No. 12 wire runs in the same conduit, and from the pull box, *B*, through the light *X*, another circuit of No. 12 wire is pulled through the same conduit. A grounded neutral at the transformer secondary supplies this building. Can some reader help me out?
Los Angeles, Calif. A. W. W.



Answers Received To Questions Asked

In his question in the December number of INDUSTRIAL ENGINEER, J. H. F. wants information on determining the charging rate of a storage battery. I will tell him of some methods I have used and which I think will help him solve his problem.

If the ampere-hour capacity of a storage battery is known, the charging rate can be found by dividing the capacity by 8. For instance, if the battery has a capacity of 80 amp-hr., then $80 \div 8 = 10$ amp. for the charging rate.

However, if the ampere-hour capacity is not known, another safe method is to charge at the rate of 1 amp. per positive plate per cell of the storage battery.

Another way of judging the charging rate is by observing the rise in temperature. The temperature of a battery which is being charged should not exceed 105 deg. F., or at the most 110 deg. F. If J. H. F. will put his battery on charge and watch the temperature for a time he may be able to determine very closely the proper charging rate. J. H. BLAIR.
Moundsville, W. Va.

* * * *

Controlling Group of Polyphase Motors with One Compensator.—I should like to know if any reader of INDUSTRIAL ENGINEER has had experience with starting and stopping a group of polyphase motors, using only one compensator. This method is given in various textbooks, but details and specifications are lacking. We have a group of 440-volt, three-phase, 25-cycle motors ranging from 40 to 75 hp. which are started under no-load conditions, and very infrequently. If one common compensator is employed in conjunction with individual, double-throw, enclosed safety switches, can the latter be equipped with quick make-and-break and made fool proof by having to be

thrown first in the starting position? How can no-voltage and overload protection be obtained?
St. Louis, Mo. M. K.

* * * *

M. K. asks in the September issue about starting several motors from one compensator. When making an installation of this kind it is well to consider all of the factors involved as the cost of the complicated wiring may offset any anticipated advantages. I have installed several such systems successfully and the accompanying diagrams show the layout of two installations that gave good results as far as safety, convenience, and low maintenance cost were concerned.

The circuit in Fig. 1, *A*, is used to control seven closely grouped motors. The compensator and switches were all mounted on one panel. As the motors can be started consecutively by one man, the compensator needs to be only large enough to handle the largest motor of the group. Oil switches are used throughout as any type of airbreak switch would be hazardous for this service. Low voltage protection is obtained from a circuit breaker in the mains.

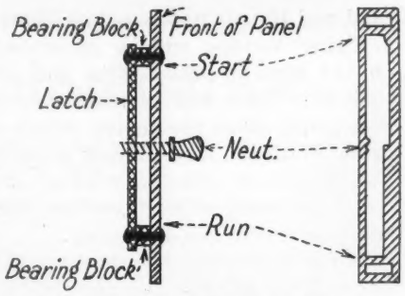


Fig. 2—Details of latch which was slipped over switch handles for safety in operation.

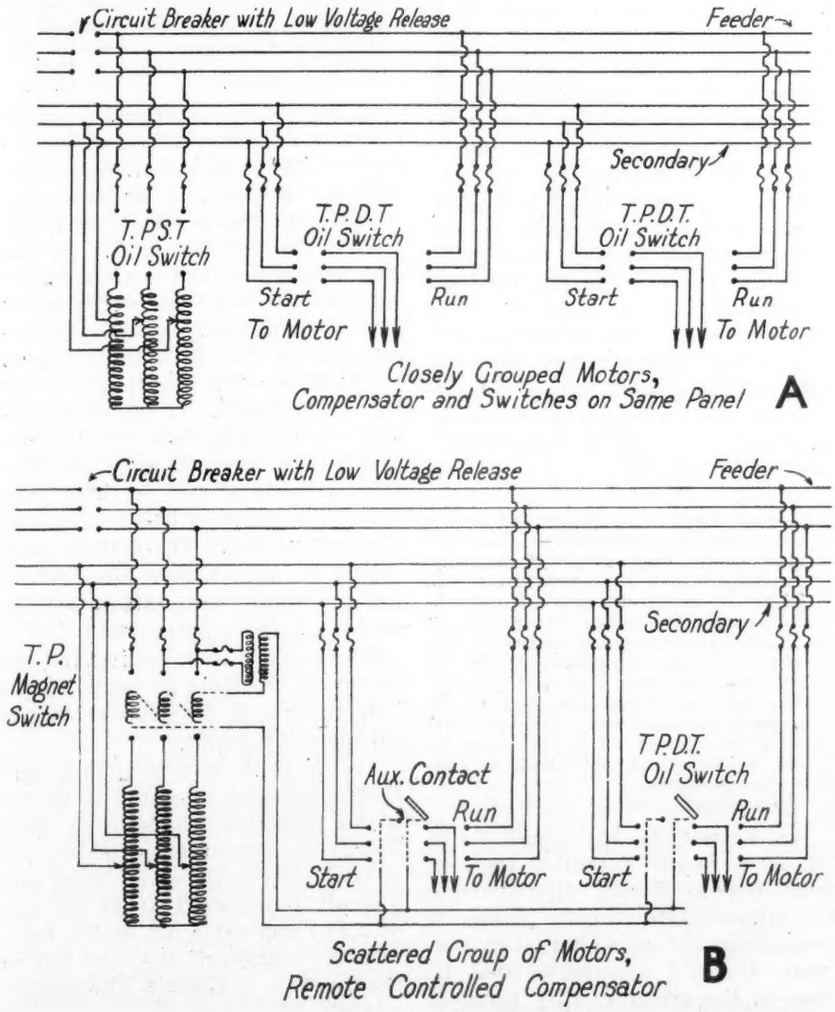
The circuit in Fig. 1, *B*, is used to control a group of motors scattered over one entire floor and has never been out of service. The autotransformer is automatically controlled by a magnet switch operated from auxiliary contacts on the individual motor switches. Fool-proof starting was obtained by mounting a sliding latch, as shown in Fig. 2, on the switch handles. Panel-mounted switches were used and a latch was put on each one. The latch is slipped over the switch handle and mounted on the rear of the panel. It is operated by the projections at the start and stop positions. This is a rather flimsy and impractical-looking affair, but it has given satisfactory service. The compensator must be large enough to handle the number of motors liable to be started at one time, as the switches are scattered and can be operated by different men at the same time. I hope that the above will be of some value to M. K. D. F. O'DONNELL.
Chicago, Ill.

* * * *

In answer to the question asked by M. K. in the September issue, motors of anywhere near 40 to 75 hp. should, for various reasons, each have its own compensator with low-voltage release and overload relays. Any one motor which is overloaded should be able to trip the relays, and yet relays should not operate at full normal load. It would, therefore, be very hard to obtain the desired results with only one compensator for a number of motors. Again, if only one compensator were used it would have to have sufficient capacity to handle the combined motor load, which would not provide protection for any one motor which is overloaded if the others happen to be underloaded at the same time. A separate compensator, with all relays set about 25 per cent above the full load rating of each motor, will provide safety and good protection.
New Britain, Conn. H. S. RICH.

* * * *

Fig. 1—Method of controlling a group of motors from one compensator.



Methods of Storing Spare Motors—I should like very much to have some of the readers of INDUSTRIAL ENGINEER describe the methods which they have devised for storing motors in such manner as to require the least possible floor space. We have over 200 spare motors ranging in size from ¼ hp. to 85 hp. A crane is available and we can pile as high as twenty feet, but floor space is limited and I must use it effectively.
Media, Pa. A. S. H.

A. S. H. asks in the October issue how motors can be stored so as to utilize floor space most effectively. Many motors of various sizes can not be stored as compactly as one would wish, but floor space can be saved by arranging them in pyramid fashion; that is, in separate pyramids.

I would suggest that he arrange four motors in a square; place short planks across them both ways and

place thereon three or four motors of a smaller size. Cover these with planks and place one or two small motors on top.

He can then arrange other pyramids in the same way, economizing on floor space. Thus, for every four motors on the floor there are four or five more above. This scheme permits a crane to take down any pyramid to reach any certain motor. Of course, it would pay to catalog them all and identify them by letters or numbers while in storage.

New Britain, Conn. H. S. RICH.

* * * *

Operating Two-Phase Induction Motor on Three-Phase Circuit—I should like to know if a two-phase induction type or squirrel cage motor can be run on a three-phase circuit, keeping the same speed and pulling the same load. I should like very much to have someone give me a diagram of such a hook-up and state if the two finishing ends of both phases or the start of one phase and the finish of another are hooked together. On what principles will the motor operate?

Chicago, Ill. J. H. B.

In answer to J. H. B., whose question appeared in the October issue, a two-phase induction motor can be reconnected to operate on a three-phase circuit. On a two-phase, 4-pole, 220-volt motor you have eight pole groups. Now in order to operate this motor on three phases, 220 volts, the coils will have to be reconnected so that you will have twelve pole groups. About 20 per cent of the coils will have to be cut out or left dead and the motor operated on the remaining 80 per cent of the coils. The speed will remain the same but the horsepower will be reduced about 15 per cent. Some of the coils must be cut out in order to keep the temperature of the motor as nearly normal as possible. Sometimes it is possible to reconnect a two-phase motor for three phases and use all of the coils, and then it will have practically the same horsepower. In emergencies a "T" or Scott connection may also be used.

Albany, Ga. B. BELCHER.

* * * *

In answer to J. H. B. in the October issue, I believe that you have the Scott or "T" connection in mind. One end of phase *A* is connected to the center of phase *B*, and the other end of phase *A* and both ends of *B* are the line leads, for three-phase operation.

An important thing about the "T" connection is that the stator must be connected long jumper or top-to-bottom in order to obtain good results. If the short jumper connection is used and the air gap is not uniform, a higher voltage will be generated on the side on which the gap is smallest. This will unbalance each phase and cause the motor to overheat. With the long jumper a north pole cannot be affected without affecting a south pole; therefore, the winding will be self-balancing.

If the motor is 5-hp. or above, 14 per cent of the number of turns or coils in phase *A* must be cut out of circuit. If this is not done there would be a higher voltage in one phase which would cause the motor to give poor results through overheating, cutting down power factor and starting torque. With the same temperature rise as when the motor was operating two-phase, the horsepower output will be in the neighborhood of 87 per cent.

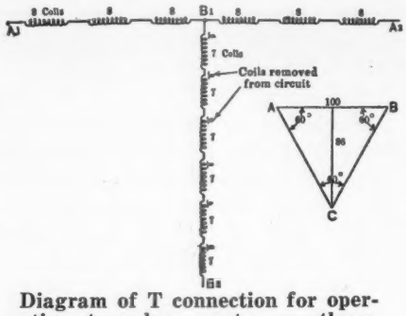


Diagram of T connection for operating two-phase motor on three-phase circuit.

If a two-phase motor is to be used permanently on three-phase it will pay to rewind it. For three-phase operation put in 1.73 times the total number of turns per phase with wire one size larger than is now used in the present winding and reconnect star with the same number of circuits as there were for two-phase operation. P. P. SCRIBAUTE.

San Francisco, Calif.

* * * *

Changing Small D. C. Motor to Operate on Alternating Current—I shall appreciate it very much if someone can tell me how I can rewind a small, 22-volt, direct-current, Hamilton-Beach vibrator motor to operate on 110 volts alternating current. The armature has 21 turns of No. 26 enameled wire and two coils per slot. The span is 1 to 6. The pitch of the leads is straight out. The two field coils are wound with 116 turns of No. 21 wire and the motor is connected in series.

Minneapolis, Minn. H. E. S.

In answer to the question by H. E. S. in the November issue on changing a 22-volt, direct-current Hamilton-Beach vibrator motor to operate on 110 volts alternating current, I would recommend that he use on the armature fifty turns of No. 35 enameled wire, two coils per slot, 1 to 6 span, and bring the leads straight out. Each field should be wound with 380 turns of No. 32 enameled wire.

I hope this information will enable H. E. S. to make the desired changes. E. H. WINKLER.

Chief Electrician.
Allen B. Wrisley Company,
Chicago, Ill.

* * * *

In answer to H. E. S., whose question appeared in the November issue of INDUSTRIAL ENGINEER, I would wind the armature with ninety-four turns of No. 33 B. & S. gage d.s.c. wire, making the connections to the commutator the same as with the old winding. Wind the fields with 522 turns, No. 28 B. & S. gage enameled wire. With this winding I believe his motor will give satisfactory results. B. BELCHER.

Albany, Ga.

* * * *

Finding Commutator Pitch of Armature Coil with Test Lamp—I should like to have one of our readers answer the following questions: (1) What is the best and quickest method of finding the commutator pitch of an armature coil with a test lamp? (2) What is the quickest method of stripping a partially-closed-slot armature?

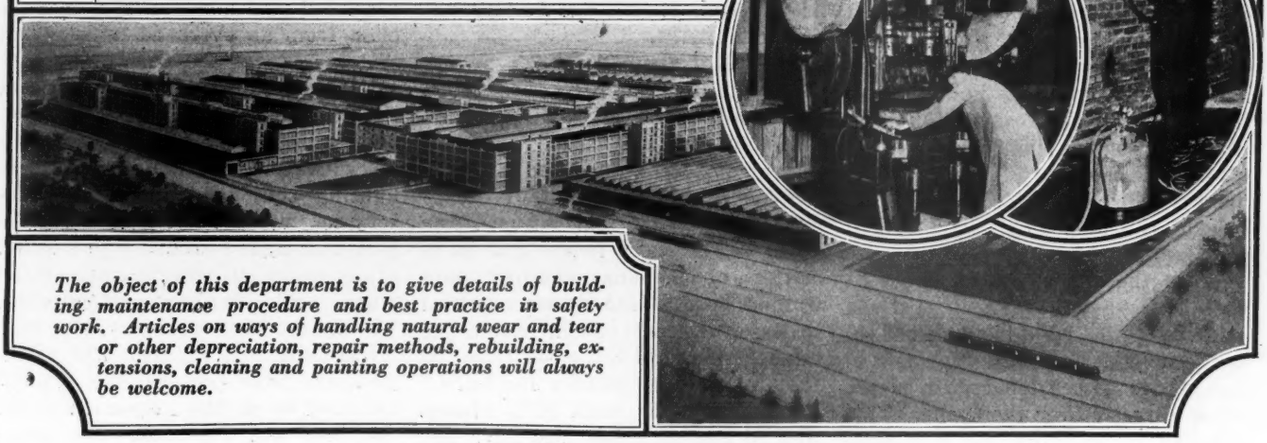
Brooklyn, N. Y. H. C.

In the October issue, H. C. wants to know: (1) the quickest way to locate the throw of commutator leads with a test lamp. I do not know whether our way is the quickest, but I'll tell him how we do it. An experienced winder can tell at a glance whether the leads connect side by side or on the half. If the leads connect side by side, raise the top leads of about two coils and then test for the bottom leads. If the leads connect on the half, raise up the top leads of any two coils and then raise the top leads of two or three coils directly opposite, or half-way around the commutator. The bottom leads should be in the bars from which the top leads were raised. H. C. asked for the quickest way, but I want to say that in testing for the throw of commutator leads, as in everything else, the quickest way is not always the best.

(2) A quick way to strip a partially-closed-slot armature is to put it in a lathe, turn the leads off right behind the commutator and cut the coils off close to the core. Then take a small, round drift about the size of a slot and drive out with a hammer the portion of the coils left in the core. GEORGE RINGNESS.

Peoria, Ill.

Building Maintenance and Plant Safety



The object of this department is to give details of building maintenance procedure and best practice in safety work. Articles on ways of handling natural wear and tear or other depreciation, repair methods, rebuilding, extensions, cleaning and painting operations will always be welcome.

Blackboard for Indicating Location of Repairmen in Shop

SO THAT WE can locate a maintenance worker, who goes out into the shop on a job which is likely to take him 15 min. or more, we have him put his name and the department that he is headed for on a blackboard located in the shop. The foreman should see that this is promptly attended to and that the man rubs out his name and location when he returns. However, this will not be lived up to unless chalk and an old rag or waste tied to a string for an eraser are kept on hand.

Probably a better arrangement would be to have a blackboard with the names of the men printed on it permanently in white paint with a space at the right hand side for the man to write in the department in which he will be. H. S. RICH.

New Britain, Conn.

Portable Screens to Protect Nearby Workers from Welding Rays

WELDING operators are well protected from welding rays by helmets or goggles, but unless the entire job is shielded in some way, other workers are endangered in cases where welding operations are performed out in the shop. As these are often of a repair nature, it is essential to have a portable screen of some form. For this, we have found a very serviceable and handy screen can be made of light wooden frames covered with 12 oz. duck.

The framework is made of 1-in. by 3-in. pine; two pieces 6 ft. long are used for uprights, two 8-ft. pieces as horizontals and a piece 10 ft. long for a diagonal brace to hold the frame rigid. To make a totally-enclosed screen, four of these frames are used. These are placed end to end 2 in. apart and covered with one strip of 12-oz. duck, 6 ft. wide, extending the full length of the four frames. The 2-in. clearance between the sections allows them to be folded together and makes a stiff corner when erected. This makes a screen large enough to enclose a space 8 ft. square which would take care of most jobs. For larger jobs, the screen can be placed around the work in such a way as to shield practically all the nearby workers. When not in use it can be folded up and placed out of the way. ELZA HERRMANN.

Middleport, Ohio.

A New Department

MAINTENANCE in industrial works is as long and as broad as the area covered by the structures in which manufacturing operations are carried on. It is as complicated as the equipment and processes used and it calls for every-day vigilance to remedy the results of natural wear and tear in order to avoid the preventable losses and wastes that are ever present in all kinds of plants.

During the past two years requests have come to INDUSTRIAL ENGINEER from readers suggesting that attention be devoted to the odd jobs about the works that the maintenance department is called upon to do. This new department has, therefore, been established as a place for the discussion of these subjects by our readers. Details of any method, results or procedure will be welcome in connection with the maintenance associated with natural wear and tear or other depreciation of floors, walls, windows, roofs, ventilation, heating, sanitation, water supply, yards, tracks, roadways, drainage, fences, etc. In this connection repairs, cleaning, moving, rebuilding and extending operations will be taken up. In addition attention will be devoted to plant safety from the standpoints of accidents to workmen, their health, safety for machines and their operation and fire protection equipment, and fire-fighting methods.

The object of this department is to establish building maintenance procedure that is being followed with good results in different kinds of plants.

Breaking Up Large Sheave Pulley in Close Quarters With Dynamite

FREQUENTLY it is necessary to remove large pieces of machinery, foundations and so on from the inside of buildings where the use of ordinary methods would require the dismantling of a wall or interfere with the operation of the plant. Such a condition was encountered in the removal of a large rope sheave, 8 ft. in diameter with a 12⅝-in. face, which was almost totally enclosed with a partition within 14 in. of one side, another partition 40 in. from the other side, and a brick wall near one face, as shown in the accompanying sketch. This pulley, which weighed approximately 2,500 lb., was rusted tight on the 6-in. shaft of a water wheel driving a generator. At first two

men tried to demolish this sheave with sledge hammers, but could make no headway. It was then decided to use dynamite.

The sequence of operations, as reported in "The du Pont Magazine," was as follows: Holes ¾ in. in diameter were drilled through the spokes close to the hub; also, a row of ¾-in. holes was drilled crosswise along each side of the hub, as may be seen from the cross-section view in the accompanying sketch. Another hole nearly 6 in. deep was drilled into the center and on one side of the hub. This drilling job took two men about 6 hr.

With the wheel in position so that a spoke was vertical, a whole stick of ⅞-in. by 8-in. du Pont 40 per cent gelatine was exploded in the groove at the top center of the wheel directly over the spoke. This resulted in splitting the rim sideways and cracking it loose from the end of the spoke. This operation was repeated around the wheel, using whole and half sticks as pieces were loosened until the entire rim was broken into pieces which one man could easily handle. Care was used to break pieces from opposite sides in sequence so that the mechanical balance of the wheel was maintained sufficiently to permit turning it without too great an effort.

After the rim was removed, the holes in the spokes were then completely filled with powder; a cartridge was broken up and the loose powder rammed into the hole with a small stick. No wadding or tamping of any kind was used and the fused cap was inserted directly into a small hole punched in the powder. Only one hole was loaded and fired at a time. This small quantity of explosive was found ample to crack the spoke so that a light tap of a sledge sufficed to break it off completely. After removing the last of the spokes, weighing about 100 lb. each, two of the four holes on each side of the hub were similarly rammed full of powder and fired. This explosion cracked the hub but did not throw any small pieces around. The one deep hole in the center of the hub was then loaded with about one-third of a stick of explosive. The explosion split the hub through the center and dropped it in two pieces on the floor almost directly under the shaft, leaving the shaft clean and absolutely unmarred or cracked. This last charge was a little too heavy and the explosion drove some small pieces of iron through a partition. This emphasized the need of caution against overcharging. It is always better to fire a second shot if the first proves too small.

A total of about 30 sticks, or 8½ lb. of du Pont 40 per cent gelatin was used, with approximately 50 caps and 40 ft. of fuse. The total cost of explosive, fuse and caps for the job was less than $4. No capping was used. This caused the shots to be very noisy and as a matter of personal comfort ears were stopped. Windows were opened to lessen concussion and hasten the removal of smoke and gases from the shot to prevent "powder headache."

In doing such work it is always well to consult those who have had experience in the handling of dynamite, as there is always a danger of over-charging. H. E. BARNES.

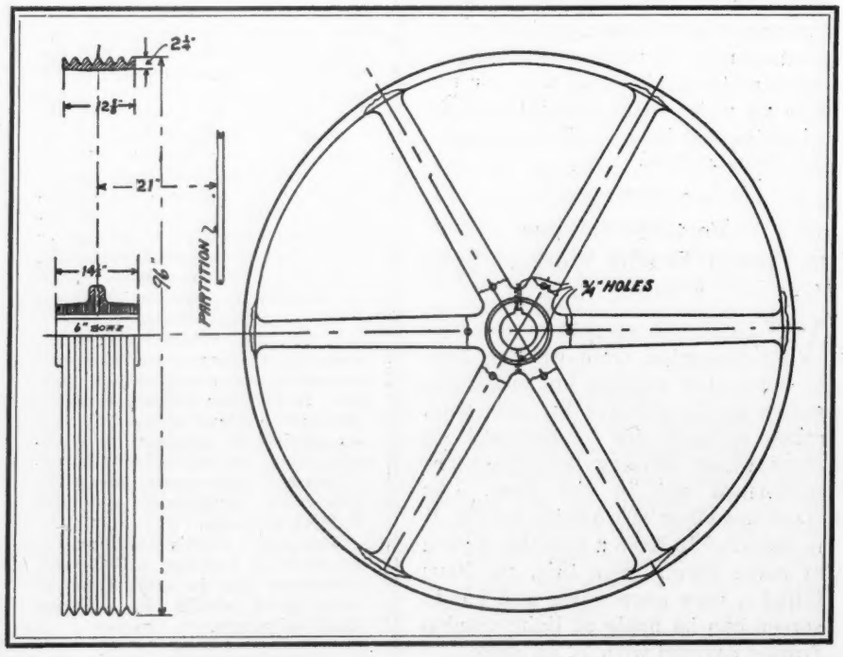
Excerpt from
The duPont Magazine.

Weekly Inspection of Factory Fire Fighting Equipment Report Card

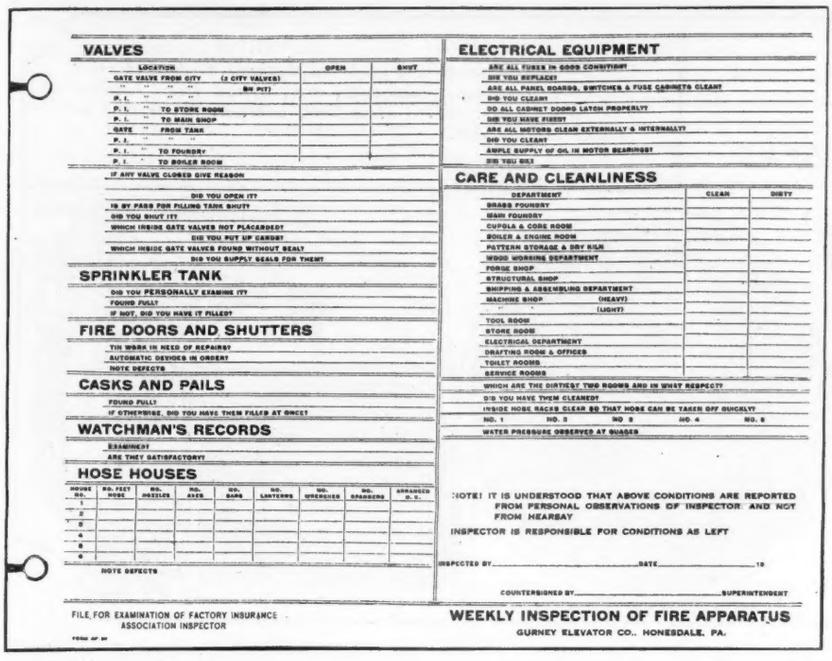
INSPECTION of fire protection apparatus and the detection of possible fire hazards are carried out in our plant after the following plan: Once a week, a responsible employee is detailed to make a careful check and record the condition of the plant as regards the items shown on the accompanying printed form. When finished this report is turned in to the superintendent, countersigned by him, and then filed in a looseleaf binder. The time of the inspection trip is usually Saturday morning or afternoon, although this time is occasionally changed.

The plant is equipped with a Rockwood full pipe sprinkler system, supplied from an overhead tank. This system reduces the amount of subsidiary apparatus necessary within the buildings, which are of slow-burning, mill-type construction, with brick walls. The additional fire-fighting equipment inside the factory consists of several lines of hose permanently attached to stand pipes, pails of sand in the forge shop, and Pyrene extinguishers placed near the larger pieces of electrical apparatus. These hand extinguishers have replaced the "casks" referred to on the inspection sheet. Refilling and replacing the extinguishers is a responsibility of the foreman of the department in which they are located.

Six small hose houses, which are stationed about the grounds of the plant, contain hose equipment for fighting fire originating on the outside of the buildings or in the storage yards, and thus supplement the work of the sprinkler system. These hose houses are located with a view towards making them effective for fighting fires originating on adjoining properties. The value of this idea as a matter of self-protection is worth while. A fire hydrant with a lock wrench attached is located in each hose house. In the inspection of these houses, the arrangement of



This sketch shows how an 8-ft. by 12⅝-in. rope sheave was broken up by blasting.



VALVES

LOCATION	OPEN	SHUT
GATE VALVE FROM CITY (2 CITY VALVES)		
" " " " (IN PIT)		
P. I. " " "		
P. I. " TO STORE ROOM		
P. I. " TO MAIN SHOP		
GATE " FROM TANK		
P. I. " "		
P. I. " TO FOUNDRY		
P. I. " TO BOILER ROOM		

IF ANY VALVE CLOSED GIVE REASON

DID YOU OPEN IT?
IS BY PASS FOR FILLING TANK SHUT?
DID YOU SHUT IT?
WHICH INSIDE GATE VALVES NOT PLACARDED?
DID YOU PUT UP CARDS?
WHICH INSIDE GATE VALVES FOUND WITHOUT SEAL?
DID YOU SUPPLY SEALS FOR THEM?

SPRINKLER TANK

DID YOU PERSONALLY EXAMINE IT?
FOUND FULL?
IF NOT, DID YOU HAVE IT FILLED?

FIRE DOORS AND SHUTTERS

TIN WORK IN NEED OF REPAIRS?
AUTOMATIC DEVICES IN ORDER?
NOTE DEFECTS

CASKS AND PAILS

FOUND FULL?
IF OTHERWISE, DID YOU HAVE THEM FILLED AT ONCE?

WATCHMAN'S RECORDS

EXAMINED?
ARE THEY SATISFACTORY?

HOSE HOUSES

HOUSE NO.	NO. FEET HOSE	NO. NOZZLES	NO. AXES	NO. CANS	NO. LANTERNS	NO. WRENCHES	NO. SPANNERS	ARRANGED N. O.
1								
2								
3								
4								
5								
6								

NOTE DEFECTS

ELECTRICAL EQUIPMENT

ARE ALL FUSES IN GOOD CONDITION?
DID YOU REPLACE?
ARE ALL PANEL BOARDS, SWITCHES & FUSE CABINETS CLEAN?
DID YOU CLEAN?
DO ALL CABINET DOORS LATCH PROPERLY?
DID YOU HAVE FIXED?
ARE ALL MOTORS CLEAN EXTERNALLY & INTERNALLY?
DID YOU CLEAN?
AMPLE SUPPLY OF OIL IN MOTOR BEARINGS?
DID YOU OIL?

CARE AND CLEANLINESS

DEPARTMENT	CLEAN	DIRTY
BRASS FOUNDRY		
MAIN FOUNDRY		
CUPOLA & CORE ROOM		
BOILER & ENGINE ROOM		
PATTERN STORAGE & DRY KILN		
WOOD WORKING DEPARTMENT		
FORGE SHOP		
STRUCTURAL SHOP		
SHIPPING & ASSEMBLING DEPARTMENT		
MACHINE SHOP (HEAVY)		
(LIGHT)		
TOOL ROOM		
STORE ROOM		
ELECTRICAL DEPARTMENT		
DRAFTING ROOM & OFFICES		
TOILET ROOMS		
SERVICE ROOMS		

WHICH ARE THE DIRTIEST TWO ROOMS AND IN WHAT RESPECT?
DID YOU HAVE THEM CLEANED?
INSIDE HOSE RACKS CLEAR SO THAT HOSE CAN BE TAKEN OFF QUICKLY?
NO. 1 NO. 3 NO. 4 NO. 5
WATER PRESSURE OBSERVED AT GAUGES

NOTE! IT IS UNDERSTOOD THAT ABOVE CONDITIONS ARE REPORTED FROM PERSONAL OBSERVATIONS OF INSPECTOR AND NOT FROM HEARSAY

INSPECTOR IS RESPONSIBLE FOR CONDITIONS AS LEFT

INSPECTED BY _____ DATE _____ 19

COUNTERSIGNED BY _____ SUPERINTENDENT

FILE FOR EXAMINATION OF FACTORY INSURANCE ASSOCIATION INSPECTOR

WEEKLY INSPECTION OF FIRE APPARATUS
GURNEY ELEVATOR CO., HONESDALE, PA.

Once a week, a responsible employee makes a careful check of the conditions of the plant in regard to the items mentioned above.

the hose, couplings, and fittings is checked to see that they are in shape so that there will be no confusion in putting the equipment into use.

To insure the constant effectiveness of the sprinkler system, it is necessary that the state of the water valves be carefully observed. Therefore, this is the first matter taken care of on the inspection sheet. Next the heart of the system, the sprinkler tank, is looked after. The accessory protective devices and apparatus are then inspected as indicated.

Because dirt and disorder are regarded as the greatest of the common fire hazards, particular attention is given on the inspection trip to the conditions of the various plant departments. The last two divisions of the inspection sheet make it difficult for any unfavorable or dangerous conditions to go undetected for any length of time as they require the inspector to state definitely the dirtiest two rooms he has noted. This draws the attention of the superintendent to the sections of the plant which require attention, yet does not make the inspector feel any compunction with respect to his fellow-employees who are responsible for the places in question. Oily waste and rags are required to be deposited in galvanized-iron waste cans, with hinged covers, located at several points in the shop. Floor men regularly keep the floor clear of scrap and litter so that there should be no excuse for any department not being in first-class condition.

Semi-annually, the insurance company's inspector makes an inspection trip with the plant inspector. At this time, water pressures at the hose nozzles are measured, and the condition of the hose lines as regards water tightness is noted. The inspector then checks over the filed reports of the weekly inspections. The two inspections are thus tied together and serve as a check on each other. This increases the effectiveness of the plan in use, and takes full advantage of the insurance company's assistance in rendering conditions safer.

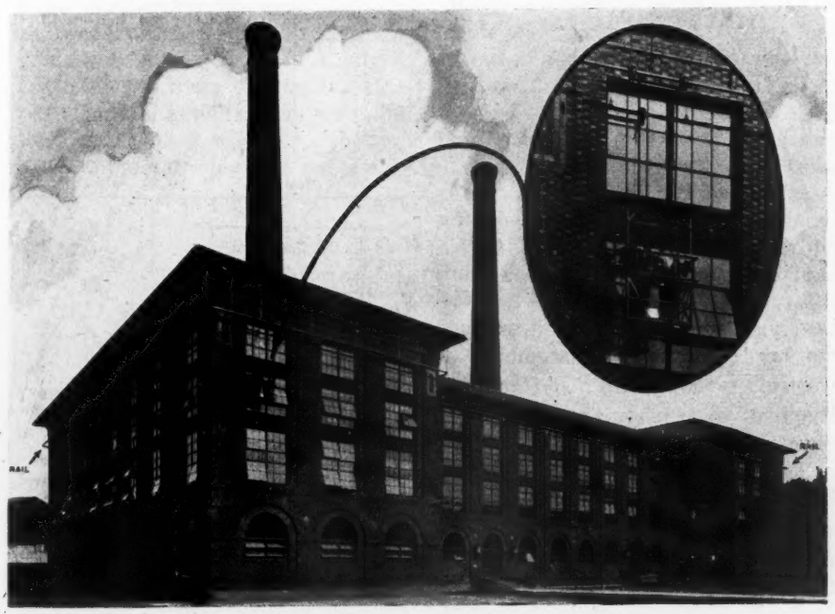
J. M. WALSH.
Gurney Elevator Company,
Honesdale, Pa.

Arrangement for Cleaning the Outside of Large Windows Safely

WITH the large increase in the use of glass windows in the modern industrial plant has come an additional problem of cleaning, painting, and repairing. Glass, unless it is kept clean, soon loses much of its lighting value. The windows are, however, often too large or too high, to be washed from the windowsill. Also, it is not always possible to use ladders, which at best are cumbersome and unsafe.

The accompanying illustration shows an application of a tramrail system (Cleveland Electric Tramrail Division of the Cleveland Crane and Engineering Co., Wickliffe, Ohio) which was installed on the pumping station of the Water Works department of the City of Cleveland to facilitate the cleaning of windows, some of which are 60 ft. above the ground. Before the installation of this system, the work was done by contract at a cost of $550. As the work was done from ladders, it was necessary to handle a ladder 66 ft. long to get at the upper windows.

Since the installation of this system, two employees do the washing of the windows in about a week's time. With this installation the men are in no danger from falling as would be the case with a ladder. In addition, the installation is available for replacing broken glass, painting, pointing brickwork and other miscellaneous outside duties.



With this tramrail and cage two men wash the windows on this entire building, in about a week.

SERVICE
around the works

For this section ideas and practical methods devised to meet particular operating conditions are invited from readers. The items may refer to inspection, overhauling, testing or special installations.

How to Use Rope in Pulling Stranded Cable

ONE WAY to pull a wire was shown in the June BULLETIN of the Pacific Power and Light Company. The story was told so interestingly that most of it is reproduced here.

"While we were busy making blocks to pull a section of wire an old workman ambled up and after looking on for a while said: 'Think maybe I can rig up something that'll work just as good as those blocks and without half the trouble.' Picking up a piece of rope the old man gave it a simple twist around the wire and said: 'There, that'll pull your old wire.' And it did.

"Here's the trick. Take a piece of rope and tape one end. Loosen the strands by twisting against the lay of the rope, place the rope on the wire, wrap it around four or five times, as shown in the accompanying sketch, loosening the strands as the rope is wrapped, and give a twist of the wrist. Simple, isn't it? Hard to explain and perhaps hard to work at the first or second attempt; but take a look at the sketch and remember that the rope is not weaved through the wire, but simply wrapped around it, as though the wire were a strand of the rope. Try it several times and once you get the hang of it you can't forget it."

New York City. E. H. H.

One end of the rope is taped and the strands are unloosened by twisting against the lay. The rope is then wrapped several times around the cable and twisted to tighten it.

Worn Bearings Cause of Starting Trouble in a Small Motor

THE EXPERIENCE of the writer in repairing a fractional-horsepower, single-phase motor shows how mechanical defects may often be the cause of trouble which is attributed to faults in the windings. A thorough examination of the motor seemed to indicate that only a new starting winding would be required. The bearings seemed slightly worn but did not appear to be worn enough to require replacing. After inserting the new starting winding the motor ran satisfactorily until the load was put on; then the motor would not run fast enough to throw out the centrifugal switch.

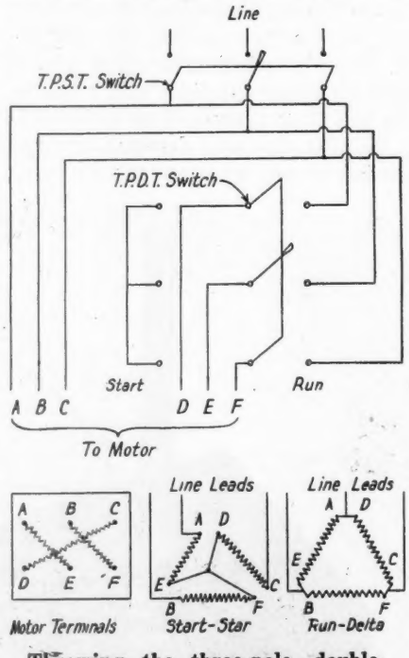
After worrying with the motor windings for several weeks during odd times, I finally decided to tin the bearings and see if they were the cause of the trouble. After the bearings were tinned and reamed out and the motor assembled it worked satisfactorily. After new bearings were made and inserted it gave no further trouble.

Tinning bearings of fractional-horsepower motors will frequently serve in an emergency, providing adequate lubrication is provided.

Albany, Ga. B. BELCHER.

Emergency Method of Starting Star-Delta Motor

A THREE-PHASE motor wound for use with a star-delta starter was recently sent to us for temporary installation on an emergency job. When the motor came it was found that the starter had not been included in the shipment. In order to avoid delay in putting the motor in service, and comply with the requirements of the power company, the method of starting shown in the



Throwing the three-pole, double-throw switch to the left gives the star connection for starting the motor. For the running position the switch is thrown to the right, which connects the motor windings in delta.

accompanying diagram was used with satisfactory results. As will be seen, a three-pole, single-throw knife switch was used as a line switch and a three-pole, double-throw switch served to change the connections of the motor winding from star to delta for starting and running, respectively. After throwing in the line switch the double-pole switch was placed in the starting position, giving a star connection for the motor windings and impressing about 58 per cent of the line voltage on them. As soon as the machine was up to speed, the switch was thrown to the right or "run" position with a quick motion, thus giving the delta connection, with full line voltage across each phase of the winding.

FREDERICK KRUG.
Comerio Falls, Bayamon,
Porto Rico.

Trouble from Grounded Rheostat of Motor-Generator Set

AN INTERESTING case of trouble came to the writer's attention recently on two synchronous motor-generator sets (150-kw., 250-volt) which were installed to supply power to a ground-return traction system using mine locomotives. One machine was tested and tried out under load and several days elapsed before the second machine was ready for a trial. The latter machine was run up to speed, the exciter rheostats for the synchronous motor were adjusted for the maximum power-factor correction and the voltage on the direct-current generator built up to 250 volts. The outside feeders were connected to the bus, one side of the feeders being connected to ground, the machine circuit breaker was closed and then the knife switch was closed. A slight flash occurred when this switch was closed and the voltmeter went to zero, while about 50 amp. showed on the ammeter only for a second. Such a circumstance indicated some derangement of the field circuit which was present only when the generator was connected to the feeder having a grounded negative lead.

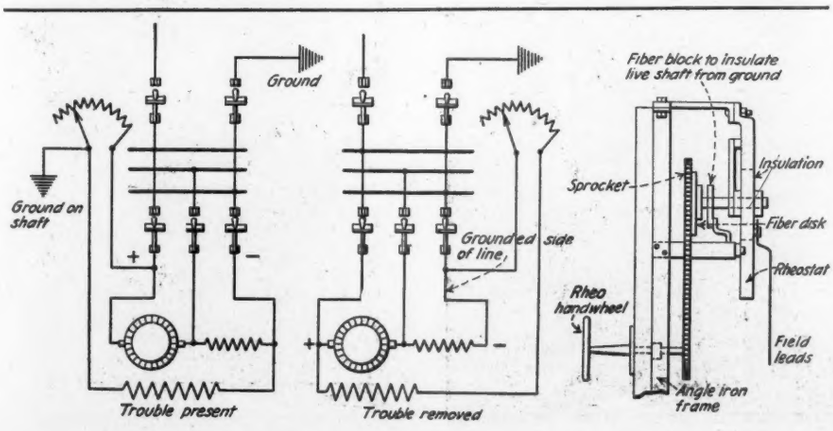
With the machine switch open a test of the generator-field leads indicated a solid ground. The leads to the rheostat were disconnected and the generator and all leads tested clear but the ground remained on the rheostat terminals. The construction of the rheostat was such that its frame was insulated from the wiring, but its shaft was connected solidly to the arm of the moving contact. The shaft was insulated from its driving sprocket by a fiber disk between the sprocket rim and the hub. However, a close inspection of the rheostat mounting revealed an iron brace acting as a bearing for the shaft. After the first machine was tried out this brace had been added to give more support to the shaft because the spring in the shaft permitted sufficient slack in the operating chain to cause it to jump off the sprocket. All the equipment had been tested out for grounds and continuity of circuits before the first machine had been tried out. For this reason, the electrician installing the iron brace neglected, or thought unnecessary, a second testing for grounds; possibly he assumed that the addition of a piece of iron to the frame would not alter the circuit. This is a common mistake and one that should be watched by wiremen inasmuch as alterations or additions are often made after equipment is installed and every change or addition which is made should be subjected to close scrutiny and proper tests.

In this instance to clear the trouble it was necessary only to remove the support, saw about 2½ in. from the iron bar and bolt on a piece of ½-in. fiber drilled to fit the shaft of the rheostat and serve as an outboard bearing. To reduce the potential stress on the insulation of the rheostat and lessen the hazards in working on the rheostat, the negative or ground side of the line was connected to the rheostat and from the rheostat the line passed through the shunt fields and thence to the positive terminal of the generator.

J. ELMER HOUSLEY.
Electrical Engineer,
Aluminum Ore Company,
East St. Louis, Ill.

The rheostat was unintentionally grounded by addition of an extra iron bearing to support shaft.

As shown at the left the rheostat was originally connected in the ungrounded side of the field circuit. To remove the trouble a fiber bearing was substituted for the iron bearing, as shown at the right. As a further safeguard the rheostat was connected in the grounded line of the field circuit.



Lamp Indicator Prevents Blocking Up of Pipes in Sawmill

WHEN one motor in a group of inter-dependent machines stops it often causes trouble unless some means is used to indicate the breakdown. Such was the case in our wood mill and cabinet shop, where an exhaust system is used to collect the sawdust and shavings from the numerous machines. The sawdust and shavings are collected by sheet-metal pipes, one end of which leads to a large main pipe about 4 ft. in diameter and the other ends to hoods situated over each of the cutting tools, with some placed near the floor to collect the sweepings. A large fan in this main pipe, operated by an alternating-current motor, in turn conveys the refuse direct to the boiler house where it is burned. Through this system the machines and floors are kept exceptionally clean. In addition to this main fan or exhauster other fans, which are driven by 40-, 50-, and 75-hp., 550-volt, three-phase, alternating-current motors are each connected to a group of small pipes to individual machines at various points about the shop and act as boosters to gather the sawdust and shavings and discharge it into the main pipe.

The fan nearest to the boiler house, which may be called the main fan, is the most important, inasmuch as it conveys directly to the furnace all of the material collected by the other three fans. In case it stops for any reason, the other fans must likewise be stopped; otherwise,

the pipes soon become blocked, causing considerable inconvenience. The fans and motors are mounted overhead and when the main fan stops, as it does frequently owing to blown fuses or other causes, this fact would not be noticed because of the noise of the surrounding machinery until the pipes were effectively blocked. It requires considerable time and labor to clean these out and interferes to some extent with the operation of the wood-working machines.

Finally, in order to prevent this trouble I placed six 16-cp., 250-volt lamps across the motor leads to show when the current is on. These lamps are colored green and are located where they can be readily seen. When the lights go out we stop the other motors and prevent blocking pipes. LACHLAN A. MCEWAN.

Car Shops, Canadian National Railway,
Point St. Charles,
Montreal, Que., Canada.

One Method of Obtaining Clean Air for Air Compressors and Its Advantages

OUR solution of the problem of obtaining clean air for a 1,500 c.f.m. air compressor which was recently installed in our plant may be of interest to readers of INDUSTRIAL ENGINEER. The most logical place for the air intake was near a centrifugal-type dust collector located on the exhaust from sandblasting machines. Unfortunately this dust collector occasionally emitted a fine dust consisting chiefly of emery, iron dust and sand which would cause serious wearing of the valves, pistons and cylinders of the compressor, if it entered the air intake.

The intake pipe could, of course, be lengthened, and by making several bends, reach a place where the air was cleaner; or the intake could be near the dust collector with some sort of air filtering device installed to remove the fine dust from the air. This latter arrangement, provided a satisfactory filter was obtained, seemed best suited to the conditions, as it was not only cheaper but also would offer less resistance to the air entering the compressor.

After considering several ways to obtain clean, filtered air, it was decided to use the Midwest air filter. This filter, which is made in standard units, has a filtering medium consisting of hollow metal cylinders coated with an oily substance, "Viscosine," to which foreign particles in the air will adhere. Our needs required four of these units which were mounted on one face of a large wooden box, which is placed against the side of our power house about four feet above the ground level, as shown in the accompanying illustration. Two ordinary house window blinds or louvres, which can be swung aside when it is desired to inspect or clean the filter, protect it from snow, ice and rain. The pipe line leading downward from the chamber back of the filter conducts the clean air to the compressor. We also arranged to have two other air compressors obtain clean air by having a second intake pipe lead from the air chamber behind the filter. These older compressors have capacities of 700 and 350 c.f.m. respectively and are run mostly at night when the new machine is not in operation.

As a result the fine sand, emery and iron dust, which we especially desired to keep out of the compressor, were easily caught. Later, however, the sandblasting system was improved so that practically none of this dust was exhausted. Even then, when conditions were supposed to be quite clean about the plant, it was surprising to see the large amount of dirt and dust still collected by the filter and kept out of the compressor.

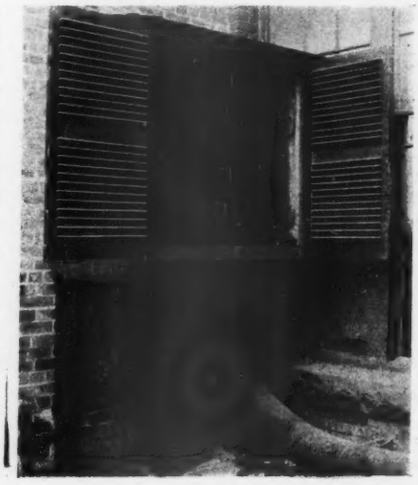
The air filter requires but little attention. Every Saturday a dirty unit is removed and replaced with a spare clean cell, so that each of the four filter units remains in service for four weeks. This is more frequent cleaning than is really necessary, as the filter could absorb much more dirt, but this arrangement makes an easy and definite schedule to work upon. The entire operation of changing cells and washing the dirty cell in hot water or blowing out the dirt with low-pressure steam does not take more than 10 or 15 min. of one man's time each week. Afterwards the cell is dipped in a bath of Viscosine, as shown in the smaller of the two illustrations, and put aside to serve as a replacement cell on the next Saturday.

From observations of this installation it is probable that many air compressors in industrial plants work under conditions which, if improved, would make the life of the compressor much longer. As an example, this plant requires about 750 c.f.m. of air and the new compressor is run at about half capacity. The two older compressors with a total rated capacity of 1,050 c.f.m. are now unable to deliver even 750 c.f.m. without running at overspeed. The reason for this is that during the years these compressors were in service dirt and dust, which had entered the cylinders with the air, had caused a continual grinding action. This gradually allowed more and more air to escape by the pistons so that the capacities of the compressors were reduced considerably below their rating.

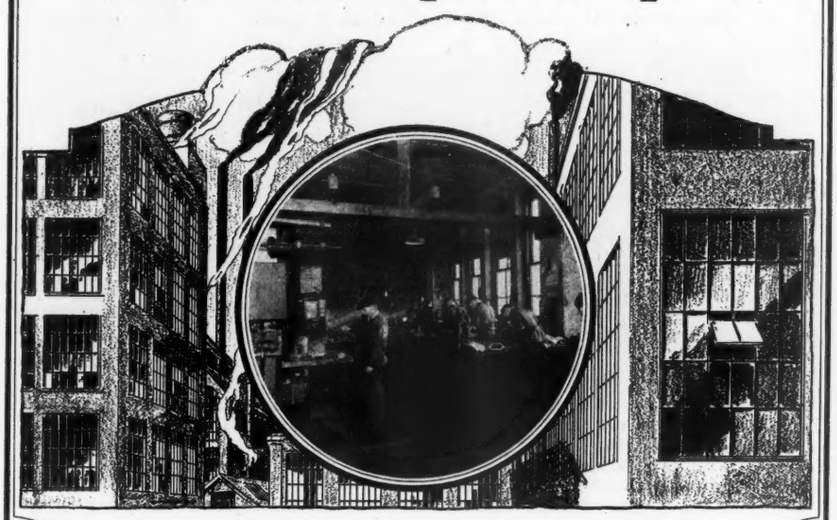
Another point noticed since using filters is the small amount of lubricating oil required. A new mechanical lubricator has been installed which helps save oil, but most of this saving is undoubtedly due to the clean air, because if dirt enters the compressor, oil must be used to flush it away. CLIFFORD H. LEIGHTON.

Chief Engineer,
Saco-Lowell Shops,
Newton, Mass.

Intake air for a compressor is filtered through the four special filter units at the left. These units are removed and cleaned as shown at the right.



In the Repair Shop



This section is devoted to repair work, large and small. Special attention is given to shop or bench tools and short cuts or improved methods. Contributions are always welcome.

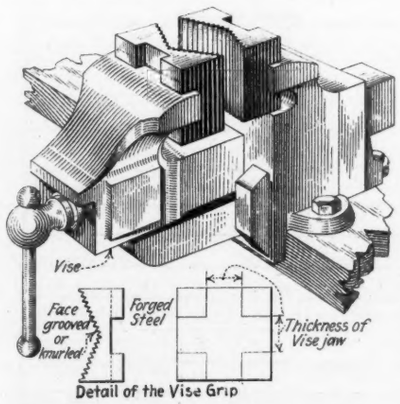
Construction of Simple Grips to Make Vise Hold Cylindrical Parts

CYLINDRICAL parts are frequently held in the vise with a file or wrapping of emery cloth to grip them, or sometimes two wooden blocks are placed in the vise and clamped down to imbed the parts in the wood. Two grips, made as shown in the accompanying sketch, will give satisfactory service and eventually pay for themselves in the saving of time and expediting of the work. These grips are demountable and are placed over the vise jaws in either position, so as to hold parts vertically or horizontally.

As shown, the grips are identical and should be made from forged steel, the grip surface being cut with angle or inclined faces, with the backs slotted in two directions to correspond to the thickness of the vise jaw. It is advantageous to cut shallow grooves in the faces or knurl them if considerable heavy work on round parts is to be done. It is also advisable to harden the grips, insuring a lasting durability for the grooved faces.

The usefulness of these grips lies in the fact that the work can be held in the position which is most convenient for the workman. Also they are easy to make. G. A. LUERS.

Washington, D. C.



With these grips round parts can be firmly held in either the horizontal or vertical position, as most convenient, in the bench vise.

Easy Method of Putting New Bars in Rotor of Induction Motor

A REPAIR-SHOP method of making a squirrel-cage winding for an induction motor was used in our shop some months ago. We had several induction motors that had been burned up in a fire. Most of these motors were of the wound-rotor type, with internal resistance and it was desired to use some of them instead of buying new ones. The stators were, accordingly entirely rewound in the ordinary way. In repairing the rotors, however, a suitable method had to be worked out.

After a thorough cleaning, copper bars from an old wound rotor were first well tinned, cut to a length about 3 in. longer than the width of the laminations on the rotor and slipped through the slots. The bars about half-filled the slots. The overhanging ends were then bent so as to bring the bars together, to form as nearly as possible a continuous ring. Some tinned copper wire was then wrapped around the exposed ends of the bars to hold them securely in place.

The rotor was then placed upright and enclosed by a bent plate of sheet iron, and all crevices were plugged up with clay. Next the whole space left in the slots was filled up with babbitt. At the same time a space was left at both ends of the laminations so as to form two rings of metal completely embedding the bent ends of the bars. After cooling, the rotors were put in a lathe and the excess metal turned off, making a neat job.

Zinc was first used instead of babbitt, but did not give good results, as it does not flow easily enough.

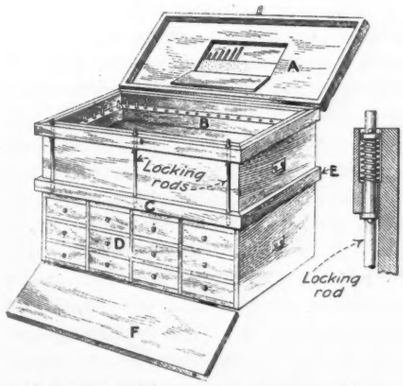
The repaired motors, which are mostly of 10-hp. and 15-hp. rating, are working satisfactorily, the only drawback being that they have a rather low starting torque.

ALBERT RUDIN.

Superintendent Electrical Dept., Abangarez Gold Fields, Costa Rica.

How to Make a Convenient Tool Box That Keeps All Tools Accessible

EVERYONE who uses tools has at some time considered the problem of making a tool chest that would hold his tools in a compact space, yet keep them so that they would be accessible. The main advantage of the chest described below is its accessibility—there is a place for everything and everything



This tool box is divided into two separate parts; the upper box is used for large tools. A large drawer between the two boxes is subdivided into small sections to hold miscellaneous bolts and screws. The lower box is fitted with drawers for small tools.

is in its place. The top section has an open space, the full width and length of the box, which is for large tools. The bottom section has drawers for the small tools.

The chest is made up of two boxes, independent of each other and separated at *E*, as shown in the sketch. This facilitates moving the chest around. The cover of the top box is cut under the panel as shown, making a space which is used for storing drills, and is fitted with a cover. Strips, *B*, are nailed around one side and the two ends of the box. Holes are drilled in these strips for automatic screw driver tips, reamers, punches and the like. The hand saw is held on the other side. The box has a false bottom below which is a drawer, *C*, the full size of the box. This drawer is divided into small compartments which hold stove bolts, screws, washers, and so on.

In the bottom box there are twelve drawers, used for pliers, screw drivers and other small tools.

The two boxes are fastened together by bolts which pass through the floor of the upper box below drawer *C* and through the top of the bottom box. When the top cover *A* is closed, the locking rods pass through drawer *C* and engage in the holes at edge of cover *F*. A padlock on hasp of cover *A* will lock entire box. J. H. SAUVE.

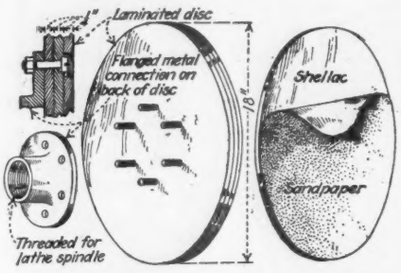
Temiskaming, Que., Can.

How to Make Surfacing Wheel for Use in Lathe

FINISHING the surfaces of parts made of wood or other material by sanding with a hand block and sandpaper is a slow, laborious process which is much less effective than the use of a sanding disk. As will be seen from the accompanying illustration, the sanding or surfacing disk is a revolving disk faced with sandpaper or emery paper of the desired grade and mounted on the head spindle of a turning lathe. The disk is revolved at a high rate of speed and the material to be surfaced is brought into contact with the face of the disk. The work may be placed on the tool rest while it is being finished. The surfacing operation will only require a small fraction of the time necessary to do the same work by hand. If wooden parts are to be surfaced, the wood does not require any previous finishing with a plane.

The surfacing wheel is easily made and the materials are usually available in the shop. The wheel disk should preferably be made from a laminated board formed by gluing three layers of ¼-in. basswood or close-grained white pine solidly together. Care should be taken to see that the grain of the layers does not run in the same direction. This laminated piece should be turned down into a disk about 18 in. in diameter and fastened to a threaded metal flange which screws onto the headstock spindle of the lathe. The disk should be fastened to the threaded flange with bolts. The heads of the bolts should be sunk into the disk and the holes filled in with wooden plugs cut off flush with the surface. This disk will be driven at the highest obtainable speed, and for that reason it should be fastened to the flange in a dependable manner. Sandpaper or emery paper of any desired coarseness may be fastened to the face of the wheel with shellac. After the abrasive paper has been put on the disk, it should be held firmly in place and the shellac allowed to dry for a short time before the disk is used. G. A. LUERS.

Washington, D. C.



The disk is made of three layers of wood glued together and firmly fastened to a threaded flange which screws onto the headstock spindle of the lathe.

Record and Inventory Card for Electrical Equipment

THE MOTOR inventory and maintenance card shown below has been drawn up primarily for the shop electrician's use. As will be noted, complete manufacturers' data as well as the operating characteristics of the apparatus, can be filled in, so that whenever it is necessary to order a bearing or to communicate with the manufacturer relative to the equipment in question, the necessary information is right at hand. This saves considerable time and trouble and does away with the usual necessity of climbing ladders to read name-plates or, at times, of shutting off the power and temporarily interfering with production.

The lower half of the card, as well as the reverse side, is ruled off to show at what times the motor has been cleaned or repaired. In this way a complete record of all work done on the motor in question is kept on file. This card can also be used for inventory purposes.

The same card can be used for generators, motor starters, compensators, oil switches, and so on, crossing off the word "Motor" and substituting the name of the other substituting the name of whatever other electrical apparatus is to be cataloged. D. FLEIGELMAN.

American Chain Co.,
Bridgeport, Conn.

With a card like this a complete record of any piece of equipment is always available.

TAG NO.		H. P.	R. P. M.
MFTRS. NAME			MFTRS. NO.
TYPE		FORM	AMPS.
AC / DC VOLTS		PHASE	CYCLES
BEARING NUMBERS:			
FRONT		CENTRE	PULLEY
CLEANED	REPAIRED		REMARKS
909-S-500-7-23-Acco		MOTOR EQUIPMENT RECORD	

Handling Materials

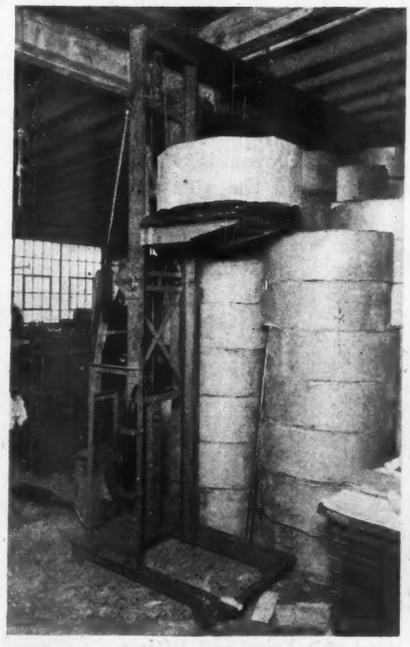
Better ways to transport and handle raw and finished parts in and around the works and the savings associated therewith will be discussed in this section

How Material-Handling Equipment Pays for Itself When Storing Stock in a Small Plant

THE VALUE of material-handling equipment, even in a comparatively small shop where the equipment is idle much of the time, is well shown by the experience of the Wirth Sales Book Company, Chicago, Ill. Here paper is received in rolls in carload lots. The former practice with the small shop was to practically stop production, as it required twelve men to unload a car. The paper was rolled on edge from the car door to the pile and then tiered by passing up from one pair of men to the next, and so on up to the top of the pile. In this way the height of the pile was limited, and it was hard work. Also, there was considerable damage to the paper through the men standing on the rolls while piling. The bruised and torn edges caused considerable trouble in the passage of the paper through the printing presses.

Since a portable tiering machine, as shown in the accompanying illustration (Standard Conveyor Company, St. Paul, Minn.), was installed, this work has been done by a man or two in about one-fifth of the time formerly required. In addition, the paper is piled high enough to get a carload in one-third of the space formerly required. One of the important points to be considered is that now the receipt of a car of paper does not interfere with production, while the elimination of the damaged paper alone would more than pay for the machine within a year.

In addition, the tiering machine is as convenient for removing the paper from the pile and lowering it to the floor. With it, one man can do the operation easily and safely and without damaging the paper. While this is a hand-operated machine, as pictured here, an electric motor may be attached to raise and lower the platform. Also, the upright is hinged, so that by loosening a few bolts the top can be tipped over for the machine to go through doorways or under low beams.



Piling paper with a tiering machine in a small printing concern.

Formerly twelve men had to stop work on production and help unload a carload of paper when received. Now one or two men do the job in one-fifth the time, with less labor, and in addition pile the material in one-third the former space. Also, as the men do not have to stand on the rolls, the saving in damaged paper alone more than pays for the machine each year.

How a Change in Operation Resulted in More Work from Tractors and Trailers

FREQUENTLY it is a question, when large quantities of material are to be handled, whether it is best to use electric trucks or electric tractors and trailers. The solution usually depends on the conditions. For example, where the material is in packages, which have to be sorted into groups and hauled a considerable distance, or where it is an advantage to have the packages loaded on mobile trucks, as in freighthouse work, it is often more advantageous to use tractors and trailers.

Such was the case at the Roanoke, Virginia, freighthouse of the Norfolk and Western Railroad. Here, during normal times, about 800 tons of freight are handled per day. To reduce the cost of handling freight by hand, an investigation was made of the possibility of using tractor-trailer methods. It was finally decided that five electric tractors and 250 trailers could be used.

These were installed overnight by removing all the hand trucks and beginning operation the next morning with a fully motorized freighthouse. It was felt that to do this was a better test of the ability of the tractor-trailers to handle the work than to try to introduce them gradually.

Here one of the factors which had been considered as detrimental to the operation of tractor-trailers, was the narrow platforms. An investigation showed that if care were taken to plan the work so as to use a minimum number of trailers and still move the freight without rehandling or delays, interruptions or interference would be negligible. An over-supply of trailers would crowd up the platform and block the aisleways and so delay the movements of tractor-trailer trains as well as interfere with the success of the installation. In addition, excess equipment would add to the initial investment required. In contrast, it would be just as detrimental to the success of the installation to have a shortage of trailer equipment.

Shortly after this equipment had been installed it was seen that time was lost by the checking clerks while waiting for empty trailers. Instead of buying additional equipment a slight change was made in the operation, whereby, instead of permitting the entire force to go out to lunch at the same time, a few men were kept working during the regular lunch period to unload the numerous trailers that were left standing when the noon whistle blew. Previously, when the force of checkers and stowers returned to work after lunch considerable time had been lost waiting for the loaded trailers to be hauled to destination, unloaded, and returned empty. Since making the change the men find plenty of empty trailers ready for immediate use upon their return. One tractor crew is also kept at work during the lunch period to move any loaded or empty trailers necessary during this period. Shortly after this equipment was installed it was estimated that there would be a saving of 30 per cent over hand trucking costs.

In the handling of local in-bound and out-board freight the tractor-trailer system has also greatly facilitated the movement of packages to and from wagons as compared with the previous slow and expensive hand trucking, which had necessitated the handling and rehandling of shipments several times. At present an out-bound shipment is unloaded from the truck or dray directly onto a trailer and remains on the trailer until it is ready to move to the proper out-bound car. In-bound freight for delivery to local consignees is loaded from the car directly onto the trailers, which are made into a train and hauled into the freight house and stored until the truck or dray calls for the consignment. The trailers are then pulled to the door where the consignee's truck is waiting with one handling.

Replacing Labor in Handling Pig Iron and Scrap at a Foundry

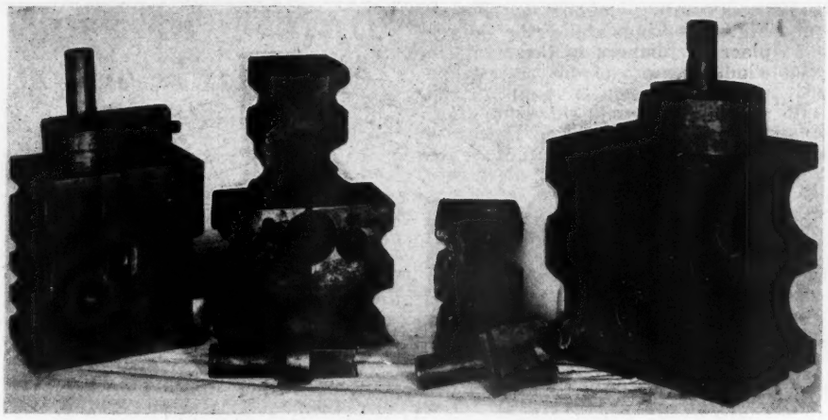
IN MANY lines of work, particularly heavy or disagreeable tasks, it is difficult to obtain laborers, especially in times when there is a shortage of the grade known as "common labor." This is especially true with many heavy material-handling operations—particularly in yard work, as in the handling of pig iron and scrap and in other similar activities. These tasks become even more difficult in the winter time when the iron is likely to be covered with snow and ice. Such jobs, however, are often well adapted to the application of some type of material-handling equipment. In fact, there is a type of material-handling equipment for almost every type of job.

Such was the case at the Bayonne, N. J., plant of the American Radiator Company. Here the pig iron was received in gondolas and unloaded by hand, with the aid of a section of portable conveyor, as shown in the lower illustration at the left in the accompanying group of pictures. While the use of such a portable conveyor is a big saving over throwing the pigs out by hand or wheeling them away from the car, there seemed to be further opportunities for improvement and lowering of costs of handling this work. With this installation, it required the time of six men, 2½ hr. or a total of 15 man-hours to unload a car of pig iron. In addition, the distance away from the car, where the pig iron could be piled without re-handling, was limited.

An electric cage-operated, mono-rail hoist consisting of an electric hoist and cage suspended from trolleys which ride on an I-beam bridge traveling over a yard run-way, as shown in the upper two of the accompanying illustrations, was installed by the Shepard Electric Crane and Hoist Company, Montour Falls, N. Y. With this installation, two men can unload a car in one hour, a saving of 13 man-hours. In addition, the material can be stored farther from the car than was possible under the previous conditions, without extra rehandling. Of course, if the material has to be moved some distance for storage, it requires more time to handle a carload of pig iron.

In addition, the crane and hoist with the magnet are available for loading pig on the small cars used to carry the iron to the cupola. This is also a heavy job and is very disagreeable when the iron is wet or covered with snow or ice. The magnet can be used to loosen the frozen pigs as well as load them. With an overhead system such as this, a large area can be reached by the crane, which permits of a better use of the yard space for storage.

Mono-rail hoist and lifting magnet for heavy handling. Formerly, it required six men 2½ hr. to unload a car of pig iron. With this installation, two men can do the work in one hour. In addition, the hoist and magnet can be used for loading the small cars or buggies in which the pigs and scrap are carried to be melted.



Worn dies can be built up by the electric arc at a fraction of the cost of new dies.

This illustration shows worn blanking dies for making eye rods, bolt heads and similar parts, which have been reclaimed. The cost of building up these dies amounts to $5 or $10 apiece, while new dies cost from $35 to $50 each. Repairing by the arc process has the further advantage that an old die can be reconditioned in much less time than is required to make a new die.

Arc Welding and Cutting Economies

(*Continued from page 29*)

is exceedingly useful for certain applications as, for example, cutting rivets and plates for repairing or scrapping steel freight cars. The cost of cutting rivets is given in the following data, based on cutting 200 rivets, ¾ in. in diameter.

Labor, 1 hr. 3 min.—90 cents per hour	$0.94
Electric power	.80
Backing rivet stubs	.66
Total	$2.40

This is only a trifle over one cent a rivet, whereas the cost of doing the same work by other methods will average from 2¼ to 2½ cents per rivet.

A 40-ft. steel gondola car was cut up by one operator in four hours into pieces small enough for four men to handle and cut in a plate shear into small pieces of cupola charging size. The cost of the operator's labor and the electric power used was only $6.80.

Risers on steel and cast-iron castings can likewise be economically cut with the arc. For example, in one instance a cast-iron riser neck 3 in. by 9 in. was cut in 5 min., and an 8-in. by 8-in. neck was cut in 17 minutes. These cost 15 cents and 52 cents respectively, for labor at 60 cents an hour and electric power at 2 cents per kilowatt-hour.

Copper is one of the most difficult metals to cut, due to its great thermal capacity and high heat conductivity. To cut large sections of copper it is, therefore, necessary to put energy into it at a very high rate in order to produce local fusion. In one case a piece of copper slag too large to be charged into a copper cupola furnace was cut up into four sections, one cut at each side and one through the center. The side cuts averaged 1½ in. in thickness and required 2 hr. The central cut averaged 4¼ in. in thickness and required 5 hr. The cutting was all done with a current of 1,000 amp. through the arc. On the basis of labor at 60 cents an hour and electric current at 2 cents a kilowatt-hour this job cost only $15.40.

Examples of Savings Made by the Use of Arc Welding in Repairing Railroad Equipment

Steam Railroads

Parts Repaired	Cost By Old Method	Cost By Arc Welding	Saving	
			Dollars	Per Cent
Eccentric straps	$ 8.97	$ 1.19	$ 7.78	86
Cross head	27.41	2.90	24.51	89
Piston head	11.98	2.56	9.42	78
Side rods	46.74	15.58	31.16	66
Cracks in tank	26.62	2.51	24.11	90
Flues	25.56	5.11	20.45	80
Frames	84.64	12.12	72.52	86
Piston rods	7.84	1.62	6.22	79
Truck frame	5.23	1.35	3.88	74

Electric Railroads

Parts Repaired	Cost By Old Method	Cost By Arc Welding	Saving	
			Dollars	Per Cent
Gear and wheel seats on axle	$27.52	$ 9.75	$17.77	64
Journal boxes	9.00	1.86	7.14	79
Air reservoir	13.23	1.83	11.40	86
Bore of axle gear	31.69	7.55	24.14	76
Controller frame	25.00	3.58	21.42	86
Commutator shell seat	17.50	3.55	13.95	80
Space block for equalizing spring	3.85	.64	3.21	83
Draw bar carriers	2.36	.43	1.93	82
Dowel pin holes in axle bearings	9.13	.98	8.15	89

Equalizers Reduce Unbalance

(*Continued from page 26*)

of so called long and short jumpers with star, delta, and other connections were given in the article by the writer in the October, 1923, issue of INDUSTRIAL ENGINEER.

The jumpers which are shown in Figs. 2 and 3 in the form of rings are used principally on windings with a large number of poles and a large number of parallel paths such as eight, ten or twelve poles with four, five or six parallel circuits. In *M* of Fig. 2 is shown an eight-pole, two-phase four-parallel connection. In this connection one long jumper is used to connect groups 3, 1, 15, 13, 11, 9, 7 and 5 together instead of using short jumpers which would connect respectively groups 1 and 3, 13 and 15, 9 and 11, and 5 and 7. This latter arrangement would give four jumpers per phase. In addition the long jumper gives the equalizer connections already referred to in

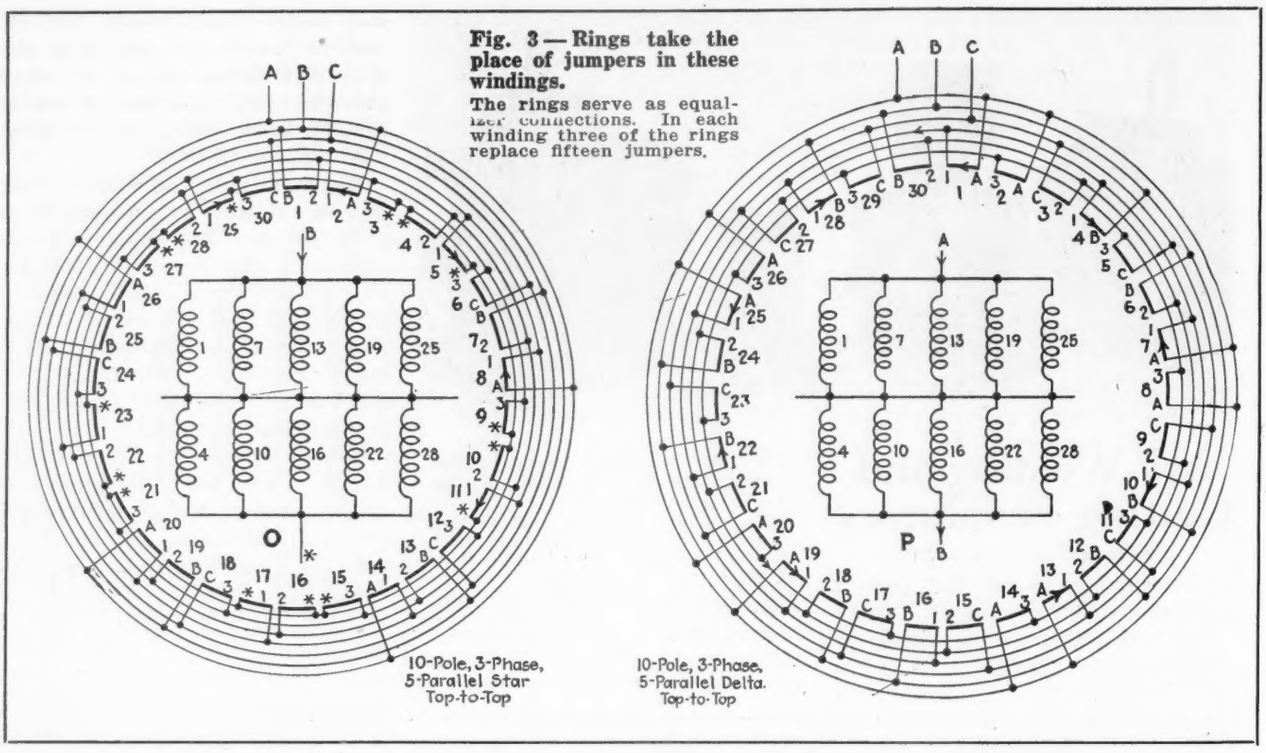


Fig. 3 — Rings take the place of jumpers in these windings.

The rings serve as equalizer connections. In each winding three of the rings replace fifteen jumpers.

the first part of this article. The long jumper also gives a better mechanical arrangement as it eliminates the crossing of group connections. In *N* of Fig. 2 is shown a ten-pole, two-phase, five-parallel diagram. There are altogether six rings, each phase having two lead rings and one jumper ring. The jumper rings serve also as an equalizer across all the five parallel paths.

In Fig. 3 are shown two more examples of ring-type jumpers. The drawing at *O* shows a ten-pole, three-phase, five-parallel star connection. For this connection there are three lead rings, one star ring which has fifteen taps to it and three jumper rings, making a total of seven rings. Sometimes the three lead rings are not used for this connection but cables are used instead. In this case the cables are made as short as possible, but they must still be rather long to connect to all five of the parallel paths. Sometimes a connection of this kind is made which seems to have only ten taps to the star ring. In this case the ends of some pairs of adjacent groups are connected together and only one lead is brought out from their junction to the star ring, thus saving time and material. This can be done between groups 3 and 4, groups 9 and 10, groups 15 and 16, and so on. In drawing *P* of Fig. 3 is shown a ten-pole, three-phase, five-parallel delta connection. This connection employs six rings, three lead rings and three jumper rings.

Reclamation Plant for Equipment

(Continued from page 23)

The rolling mill and the blacksmith shop work together in putting wrought-iron scrap into usable form.

Small round and flat scrap is cut into convenient lengths and made into fagots or bundles which are heated to a welding temperature and rolled into round or flat stock. The upper of the two illustrations shows the 12-in. rolling mill. A car of fagots can be seen at the right. Behind it is one of the heating furnaces. The rolled stock is worked in the blacksmith and forge shop (below) into car and engine forgings, pinch bars, chains, bolts, etc.

brass connectors are then removed from the carbon electrodes and sold as scrap brass. The lead salts are removed from old storage battery plates and sold, while the plates themselves are melted and cast into pigs. Brass turnings and borings are passed through a Dings magnetic separator to remove iron particles and *(Continued on page 52)*

Work of Maintenance Engineers

(Continued from page 20)

ordinary or reasonable sort of a breakdown. Other duties are: 1. To organize and control the men in the department so as to keep the labor turnover to a low figure; 2. keep records on the equipment in service so as to determine frequency and cost of repairs; 3. requisition, store and disburse all material used in maintaining the electrical equipment.

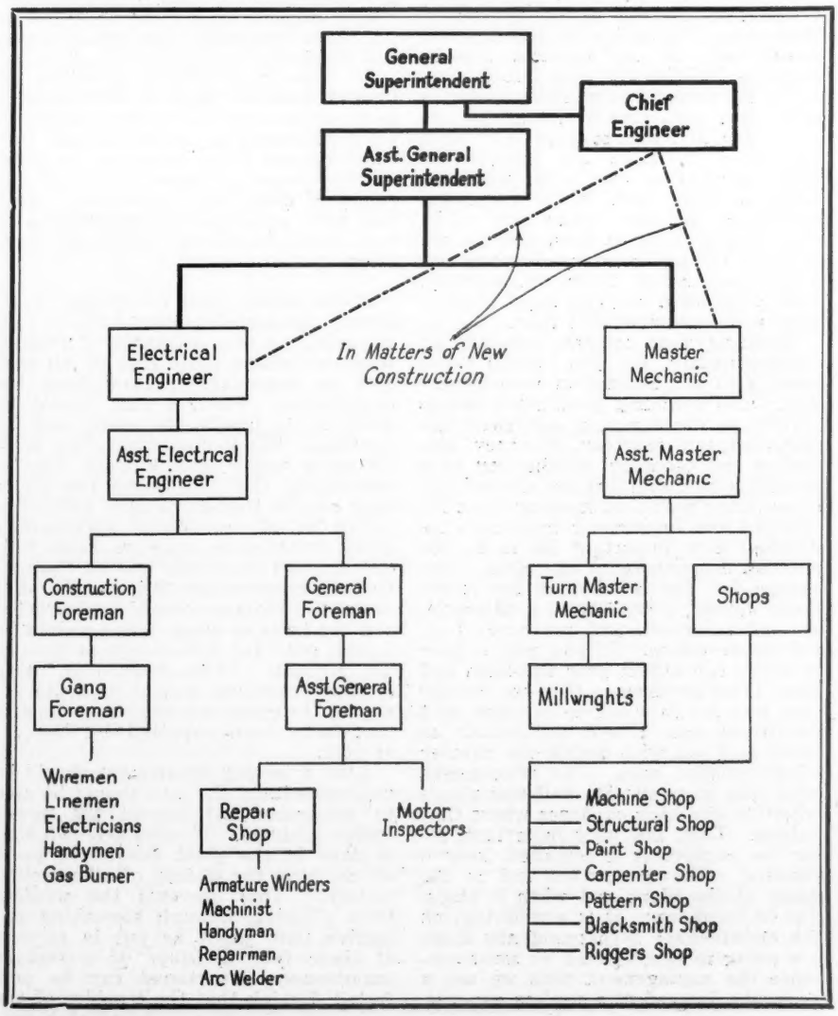
2. The lines of work that come under their supervision are as follows: 1. Design of electrical applications and layout of power distribution; 2. installation of the above; 3 operation and inspection of electrical equipment; 4. maintenance and repair of the same.

The accompanying diagram shows the department organization. As a general rule the division of work between the Chief Electrician and the Master Mechanic occurs at the motor connection to the drive. The Chief Electrician maintains the equipment from and including the point of generation or receipt of the power supply to and including the motor pinion, pulley or coupling. The Master Mechanic maintains the equipment from there on. The only disadvantage of this arrangement is that two men instead of one are held responsible for "making the wheels go 'round." Since mechanical trouble first makes itself evident by distress in the electrical end of the equipment, the electrical man usually has to first assure himself that the fault is not his and then to prove himself right he must locate the mechanical fault for the mechanical man. This results in the electrical man doing a considerable portion of the mechanical man's work. Furthermore, in quite a few plants it is a constant source of friction or buck passing.

3. The changes or rearrangements that men in charge of maintenance are most often requested to work out are as follows: 1. Make changes in the speed of a drive application; 2. make the application safer for the operator; 3. move the application to a new location; 4. improve its reliability and ruggedness; 5. extend the power distribution system; 6. extend or rearrange the lighting system; 7. design drives for new extensions; 8. design drives and power distribution for new mills.

4. The maintenance organization should have information on the following methods or repair practices: 1. Information should be obtained regarding the service and application for each type of motor and control equipment; 2. mechanical information concerning the installation of equipment, such as various forms of bedplates, motor subbases, proper meshing of gears, leveling up of armature shafts on large applications, etc.; 3. maintenance methods of locating loose bearings, worn shafts, worn pinions, and other such equipment; 4. it would be interesting to know the idea of others as to what a reasonable line of spare parts should consist of; 5. various systems and methods used in handling equipment to and from electrical repair shop, also in the repair shop; 6. system used to keep the cost of individual motors; 7. system of handling electrical stores.

Organization diagram for a large steel mill in which maintenance and construction work on 500 motors totalling 12,000 hp. is handled by sixty-five men.



W. T. Lees, Chief Electrician, Savage Arms Corp., Utica, N. Y.: The men in charge of maintenance and operation in a well organized works should be responsible for all apparatus used in connection with production from the point where electrical service begins until that power is delivered to the wheels of the machines or other appliances used in production.

2. The steam plant, shafting, belting, elevators and so on should be handled by the Master Mechanic, and all electrical work including construction, maintenance, and repairs, should be handled by the Chief Electrician, except the installation of motors and compensators, which should be done by the Master Mechanic, who is usually equipped with the necessary men and tools for this work, the installation where necessary being supervised by the Chief Electrician.

A competent force of men must be kept in the electrical department to insure continuous service. It should include men for construction work, men for inspection and maintenance and men for shop repair work. In the mechanical department there should be a gang to handle the installation of all machines, and the plant should be divided into sections with a repair man in each section responsible for all shafting, pulleys, oiling, and so forth, with a competent belt man to install, maintain, and salvage belting.

3. The most frequent changes are rearrangements of department. In our plant after the layout of machines has been received from the production department, showing the grouping of machines, the Chief Millwright and Chief Electrician will decide on the size and location of motors to handle each group. The Chief Electrician will then provide cables and panels of sufficient capacity to carry the load, and install the necessary lighting units.

L. A. Wynd, Chief Electrician, Keystone Steel & Wire Co., Peoria, Ill.: You have asked for suggestions on subjects that seem to have endless possibilities. Some of the main duties of the electrical department head in a well-organized works are:

To act in an advisory capacity to the General Superintendent on all electrical matters; to confer with the Purchasing Agent and General Storekeeper, giving the assistance of his electrical knowledge in the purchase of supplies and spare parts; to superintend maintenance and operation of all electrical apparatus by means of systematic schedules of inspection and repair; to establish and preserve a definite policy of relations between the electrical and all other operating departments, which

policy should be formulated with the idea of promoting the greatest possible harmony; and to establish a definite safety-first policy within the electrical department. This can best be fulfilled by educating electrical men up to the dangers of electrical machinery, the use of safe apparatus and strict observance of the National Board of Fire Underwriters' code.

The lines of work coming under the supervision of electrical department heads are as follows: Power distributing systems, lighting distribution, signal systems, remote- and manual-control apparatus, motors, generators, substation and power house operation, repair shop. Electrical tests on meters, motors, generators, insulation tests, efficiency tests, and so on. Distribution of power costs, estimating costs of changes or new work in the electrical system. Operation of the electrical store room.

The size of the electrical department force necessarily determines, to a great extent, the organization chart. The amount of freedom given the electrical department head to develop his organization will have great bearing on the efficiency of his department as a whole. The electrical organization should center around a man of broad practical experience in maintenance and operation. Next should come a number of key or leading men. Following the key men should come the repair men, operators, and inspectors. Some methods should be devised to train new men coming into the organization, and several men should be trained to fill any position in the department in an emergency. One plan that can be used to very good advantage to train men to think beyond their jobs is to encourage correspondence school work, and to subscribe to a good trade paper. I am getting excellent results from men in my organization who are I. C. S. students and subscribers to INDUSTRIAL ENGINEER.

The work best handled by the Chief Electrician and that handled by the Master Mechanic should be clearly defined. Experience shows that electrical work should go as far as, and include, pinions and pulleys on all motors. The Master Mechanic should take the responsibility from that point. In most plants an exception to the above is made on electric cranes, their mechanical and electrical maintenance being strictly up to the men in the electrical department.

Power and power factor surveys if carried out intelligently can be made to yield some nice returns. Substantial savings can be effected in prevention of loss of lamps by theft, breakage of the large sizes of lamps while hot by rain or snow, and vibration of lampshades. The work done by a well-organized repair department capable of pouring and machining bearings, repairing commutators and rewinding armatures and stators will save a substantial sum. The department overhauling and inspecting motors and control will, if properly organized and working systematically, show the greatest saving. This being another case of "a stitch in time."

Experience shows that more changes are necessary in the lighting and signal circuits than in any other part of the electrical system. Motor control changes, while not so numerous call for more work and effect some very fine savings in reduced burnouts. I class this change as most important.

Oscar L. Smedberg, Chief Electrician, American Car & Foundry Co., Lancaster, N. Y.: 1. The main duties and responsibilities of men in charge of maintenance are to keep the machinery in running order with the least number of interruptions and delays. Maximum production depends on this and it can be accomplished only by frequent and rigid inspection, prompt renewal of worn parts and bearing linings and seeing that all bearings are properly lubricated and kept clean. This inspection should include motors and control equipment and switches where electrical power is used. Lighting is also very important and many accidents can be avoided in industrial plants by sufficient and properly installed and maintained lighting units.

2. In the plant of the American Car and Foundry Co., Depew, N. Y., where I am employed as Chief Electrician the installation, inspection, maintenance and overhauling of electrical equipment is all handled by the Chief Electrician. Installing and overhauling of mechanical equipment is done by the Master Mechanic. Our force is divided into : (1) Armature winding and motor repair; (2) general maintenance; (3) oiling motors; (4) maintaining electric lights; (5) inspection and new installation.

3. I do not know of any changes or rearrangement that is general in all plants. Each plant has its own problems to solve.

H. M. Sherbine, Chief Electrician, Continental Motors Corp., Muskegon, Mich.: 1. The duties of Maintenance Supervisors, in my opinion, are to diagnose individually each installation, select the proper equipment, keeping in mind first cost, cost of installing, depreciation and maintenance of same. Too often we make the mistake of thinking of first cost only, which is really a minor item in the successful operation of any up-to-date plant. Competition today is keen and we are striving toward greater efficiency and higher production; therefore, we must have equipment we can keep running with a minimum of lost time.

Spending your company's money as conscientiously as you would your own, is in my estimation very important; also teaching your subordinates loyalty to the company and their fellow workmen, courtesy, efficiency, discipline and economy, eliminating to a minimum all discontent and discord and stimulating ambition, keeping them interested and impressing upon each individual how important he is to the successful operation of the plant. The reason for this is obvious for it reduces operating expense to a minimum. Do not misunderstand me here: I do not mean wages. If you pay a poor rate you can expect poor workmen and large labor turnover. Give me twenty men who are in a degree satisfied with conditions and I will accomplish as much as I will with double the number of dissatisfied men. The wide-awake man who is on the job will find places where he can keep expenses where they belong. Last, but very important, after the equipment is installed, keep it running. The production end is the heart of the plant and when it stops, due to breakdown, it is a reflection on the maintenance department and if we are going to be a success we must convince the management that we are a necessity, instead of a useless expense, which so many of them seem to think at the present time.

2. In a great many of the larger plants, the title of Master Mechanic has been discarded. The title of Superintendent of Maintenance has supplanted it. The Superintendent of Maintenance, in my estimation, should have supervision over the maintenance department, stockroom and the power house engineer who, in turn, should have charge of the power house and its employees and power house accessories; the garage foreman, who should have charge of industrial and commercial trucks, repairing and maintenance of same, also the drivers; Plant Protection Engineer, under whose supervision should come the watchmen, janitors and fire-fighting equipment; the Chief Electrician who should have the electricians, elevator operators and crane-men, battery charging and repairing, and supervision of all electrical installations, inspection and repairing of same; millwright foreman who should have charge of the millwrights, steamfitters and tinsmiths, also the installation of all machinery, hanging new motors or motor alteration after consulting with the Chief Electrician, also be responsible for shafting, belting and over-head, with the maintenance of same; the carpenter foreman should have the carpenters, painters and laborers, repairing and maintenance of all buildings, roofs and windows; the yard foreman should have the yard men and train crews. These departments should work very closely together and if the proper co-operation and harmony exist they can accomplish much.

3. This is a difficult question to answer because men in the maintenance division are quite often requested to do seemingly impossible things. One thing we are often requested to do is to re-arrange a department without shutting down the machinery. This has been accomplished successfully in our plant on several different occasions.

Archie Haist, Chief Electrician, Armstrong Spring Co., Flint, Mich.: In my opinion a man in charge of a maintenance division must first of all perfect an organization throughout his department. First, a unit should be made up to handle the oiling and inspecting. The ordinary practice is to oil every motor once a week and by instructing the men doing the oiling they can be trained to take particular notice of all conditions surrounding every installation, such as loose conduit, broken insulators and on the motors, in cases where they can be shut down, the bearings should be inspected and the belts or other drives should be looked over for any condition that is not normal. Then from that step certain provisions should be made for a gang to cover the necessary repairs that have been reported by the inspector.

Also, a testing department should be maintained and the men should be able to determine and correct the power factor problem. If armature winding is done in the plant the meter gang should have the testing of all rewound motors. This prevents the winders from slipping through something defective that might be put in service. If these four divisions of a factory maintenance department can be perfected, I think that the troubles of the

man in charge would be reduced considerably.

The Chief Electrician should not be required to move motors from one location to another, because a millwright is more thoroughly equipped for such work. Changes of speed are the most numerous and are sometimes rather hard to cover if it is impossible to change the pulleys or gears. Changes created by trying to replace a burned-out motor cover a wide range. The best method is to try to arrange for making these changes before the breakdown comes. Then the job will be more thoroughly done and is more likely to be satisfactory.

If information on conditions that might arise from a burnout could be given, such as a change from one type of motor to another, or a phase or voltage or cycle change, it might make these changes easier.

Manufacturers of testing equipment would be glad to inform persons in the use of and advantages of load and power factor testing instruments which many maintenance men would be glad to get.

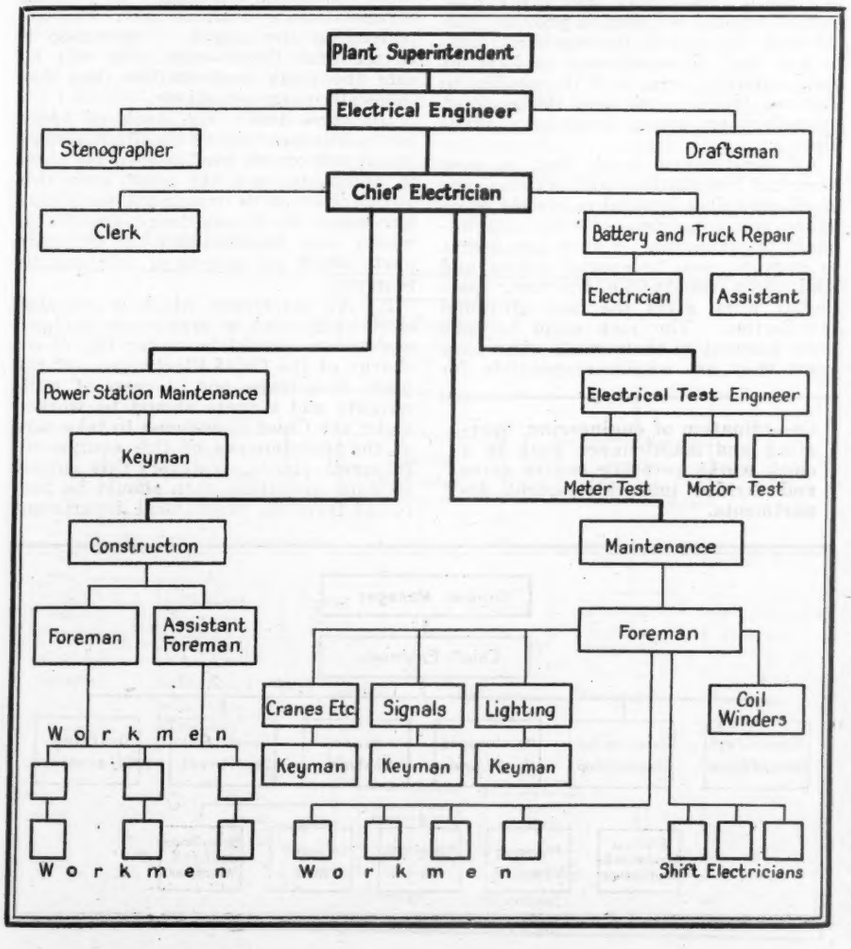
J. Elmer Housley, Electrical Engineer, Aluminum Ore Company of America, East St. Louis, Ill.: 1. The duties of men in charge of maintenance work cover a wide scope. Vision, imagination and responsibility are the chief ear-marks of a good maintenance engineer. Vision is required to foresee the trend of development in the industry and to keep clearly in mind what will be needed tomorrow to replace that which is wearing out today. Imagination plays its part in adapting the best methods of other minds to one's own problems. Responsibility means, of course, that jobs which are undertaken under his supervision will be concluded efficiently, completely, and at a minimum cost. He is responsible for the initiating of repair jobs to prevent breakdowns and for repairs after breakdowns occur. He must order materials for repairing breakdowns and for replacing materials that simply wear out in service. Original designs which prove unsatisfactory must be altered so as to function properly. He must also secure the confidence and cooperation of the men in the department if a full measure of service is to be secured from them. The plant operation foremen have duties which are specialized according to industries and will not be discussed here.

2. My ideas regarding an electrical force were given in the March, 1922, issue of INDUSTRIAL ENGINEER. In connection with electrical equipment, the work handled by the Master Mechanic should be confined to lathe work, such as making bearings and turning commutators where there are only a few and he should handle the riggers which are available for all departments. In any plant large enough to require an electrical organization it is a great mistake to allow the direction of this department to come under the Master Mechanic. A man of sufficient caliber should be made responsible for the electrical division as a unit.

3. From my observations I believe that the maintenance organization has equal opportunities in the electrical or mechanical divisions for making a saving proportional to the capital invested.

4. Changes most often made by maintenance men are in cases where the original installation does not function properly, due to improper arrangements and where the maintenance cost on old equipment becomes too high and where improvements in production quantity or quality may be made. In a large organization the engineering and maintenance organizations dovetail so closely that it is not always possible to make close distinctions as to where a job may begin or end.

Electrical organization for a plant having a power generating station with 25,000 hp. connected load and employing about 100 people in electrical work.



E. D. Chrisman, Chief Electrician, Lynchburg Foundry Co., Lynchburg, Va.: The equipment of the Lynchburg Foundry Company consists of about 2,000 hp., in d. c. and a. c., 220-volt motors. The power is bought from the Lynchburg Traction and Light Company and used without transformers for operating our synchronous and induction motors in the power house that run motor-generator sets and air compressors. The 2,300 volt, three-phase, sixty-cycle power is also transformed to 220 volts, three phase, sixty-cycles for the smaller-sized motors used for general power purposes. The motors run from ¼ hp. to 170 hp., a. c., and from 1 hp. to 50 hp., d. c., both 220 volts. The motor-generators supply d.c. for our traveling cranes and small hoists and the air compressor is driven by a 2,300-volt induction motor.

The service that machinery gets around a pipe and plow foundry is very severe on account of the ever-present flying sand and dust. The equipment is handled roughly and worked to the very limit. The floor motors are used for the completion of the foundry work and for the blower for each of four cupolas.

The maintenance crew consists of two electricians, one machinist, oiler and belt man and one helper who takes care of the plow point machine heaters. The electrical equipment is oiled by the oiler and any undue noise or anything that does not look right is immediately reported to and inspected by the Chief Electrician. The operators of the floor machines are watchful for trouble and immediately notify the chief or his assistant when anything goes wrong. Daily inspections are carried on while everything is in operation; any machine that develops trouble is shut down and the chief is called and decides whether the machine shall be repaired immediately or after the day's run. The cranes are inspected by the chief or his assistant during operation and thoroughly after each day's run. The motors, controllers, shoes, brushes, bearings, brakes and brake coils especially are gone over, and any needed repairs are then made so as to have everything O. K. by morning for the next day's run.

The Superintendent and Master Mechanic are called in on any serious or heavy breakdown of a mechanical nature. The Superintendent is a past master mechanic and able to give practical advice on all mechanical troubles. The operators on the cranes help on repairs and breakdowns and are held responsible for a clean and orderly

crane. The chief has full authority and is held responsible for all electrical and mechanical equipment and has the full co-operation of the Master Mechanic in all breakdown jobs and has full power to call for any help needed to get the repairs made as soon as possible so as to get the equipment back in service.

The chief has full charge over the operation and control of the power house equipment, being held responsible for its operation. All storeroom and plant orders are issued by the chief for any electrical or mechanical repairs or supplies needed. Spare parts, such as armatures, field coils, brake coils, spare controllers, faceplate resistance contacts, segments, brushes, gears, pinions, and so on, are carried to handle most of the breakdown troubles. Spare belts are carried for all important drives. Spare motors complete are carried for all key devices and only a short time is required to unbolt one motor and bolt down the other.

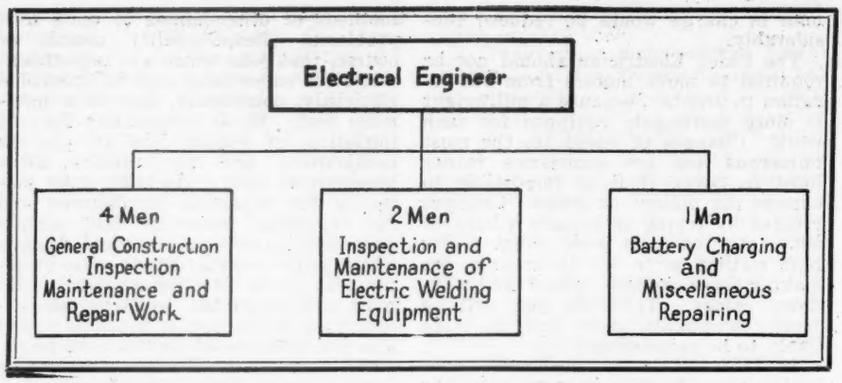
Our greatest changes are of the nature of changing motors or machines to get better results or higher production, or changes from one department to another to hasten production or add to present equipment. Other changes include switches which make it possible to operate motors on different controllers and *vice versa*, to help out in a rush or breakdown.

H. E. Reinhold, Chief Electrician, American Sheet & Tin Plate Co., New Philadelphia, Ohio.: As a Chief Electrician my duties are to make all new installations, both motor and lighting, and to order all equipment, both for new work and for repairs. I am responsible for the continuity of operation of all electrical equipment; for the prompt, economical and efficient repair of same, and for the regularity and efficiency of the inspection of this equipment.

From my experience in repairs to electrical equipment, the mechanical portions, such as truing of armature shafts, turning of commutators, making bushings and relining of babbitt bearings should be handled by the Master Mechanic, except in cases where the plant is of such proportions as to justify the carrying of a first-class mechanic on the electrical force.

A maintenance organization can show the greatest economy by a faithful, conscientious, well-planned inspection of all electrical equipment. The old adage, "A stitch in time saves nine" is nowhere better exemplified than in this connection.

The following may be irrelevant, but I believe that a little discussion of this matter in the pages of INDUSTRIAL ENGINEER might help the Chief Electrician. On several occasions in the last few years I have been called upon to make installations of electrical equipment. One just recently ran into thousands of dollars, in conjunction with mechanical machinery. In all cases the mechanical end of the job is furnished with complete details and plans but the electrical end of the job does well if the foundation bolts for the motors are shown on the general plan. With the advent of relay control for heavy and reversing motors it becomes quite a problem to take care of this after the mechanical end of the job is nearing completion. In the old days it was possible to stick a switch and rheostat almost any place at any time, but with a conduit installation and up-to-the minute equipment, this is impossible. I think it timely therefore that we of the electrical game insist that the engineers and drafting room find a place for our equipment the same as they do for the mechanical men.



Maintenance organization for metal-stamping plant having 1,100 hp. in motors.

These men ake care of all electrical equipment, including motors, of which there are 140 ranging from 1/12 hp. to 100 hp., welding machines, eight industrial trucks, signal systems, light and other equipment.

J. Jensen, Chief Electrician, Dominion Oilcloth Co., Montreal, Quebec, Canada: The duties of the men responsible for maintenance and operation in a well organized works are to see that all machinery, electrical and mechanical, is put up in such a way that every protection against accident is provided for the men who handle the machines; also to see that all machinery is kept in good running order and if possible to discover trouble and have things fixed up before an actual breakdown takes place.

All construction work, that is, new electrical installations and maintenance of all electrical apparatus, should come under the supervision of the maintenance organization. I have found that to appoint men to special duties and hold them responsible for their particular work gives the best all-round satisfaction. The men seem to take more interest in their work when they know they are wholly responsible for the continuous operation of machines under their care.

All work, mechanical as well as electrical, in connection with electrical machinery and apparatus should be handled by the Chief Electrician, and he should be held responsible. Mechanical machinery, shafting, pulleys and bearings (not motor or generator bearings), belts, etc., should be left to the Master Mechanic.

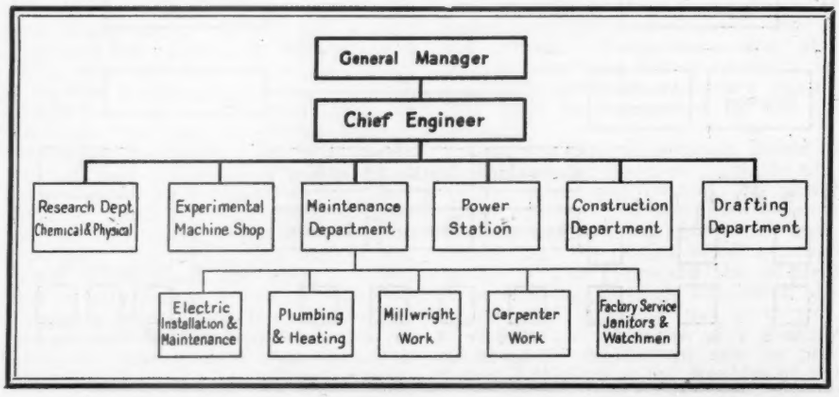
On repair work by continually being on the lookout for trouble and making the repairs before a general smashup takes place. The old saying, "A stitch in time saves nine" applies here.

O. C. Callow, Chief Electrician, The Trumbull Cliffs Furnace Co., Warren, Ohio: 1. The main duty and responsibilities of the man in charge of maintenance in a modern industrial plant is continuity of operation with low maintenance costs. In order to secure these results he must have an efficient organization, containing men who are trained to the slogan, "Prevention is Better than Cure"—men who will locate the weak spots before they find them stopping operations.

He must study his stock of spare parts, being careful to maintain a stock which will enable him to keep his plant in operation, and yet must keep this stock down to a minimum to obtain low costs, as a very large amount of money can become tied up in spare parts which are seldom or infrequently required.

2. All machinery which is operated electrically, such as cranes, ore bridges, and so on, should be under the direct charge of the Chief Electrician. If the plant is a large one, a crew of millwrights and riggers should be worked under the Chief Electrician to take care of the maintenance of this equipment. In small plants, however, this cannot be done and these men should be borrowed from the mechanical department

Co-ordination of engineering, operating and maintenance work in a clock works covering twelve acres and divided into thirty-eight departments.



as required; their work still being under the control of the Chief Electrician. This calls for very close co-operation between the Chief Electrician and the Master Mechanic, the two departments working as a unit—a thing not always found in industrial plants, but most desirable.

All motors should be installed by the electrical department and lined up by them. All pinions, pulleys and couplings should be under this department.

The average motor inspector is not as a rule a first-class rigger and millwright; so it is sometimes advisable to somewhat restrict his work to the electrical end and employ a man or two for the mechanical work.

3. In plants which shut down over the week-end, or on Sundays, there is a much better opportunity to take care of the maintenance than in plants which run continuously, such as blast furnaces and coke oven plants. A certain amount of equipment can be scheduled for overhauling on each Sunday so that everything is overhauled after a certain time and a complete record can be kept of what work has been done and when. When there is no regular shutdown period, the electrical department must keep their equipment operating and do their overhauling when a shutdown is required for other purposes. As an example: Should the air be taken off of a blast furnace for any reason, the Chief Electrician should see to it that all equipment involved in this shutdown is overhauled. A record of work which is to be done at such times should be kept. By taking advantage of these shutdowns the electrical department can get by without any delays credited to them.

4. A maintenance man may be called upon to make a great number of changes covering practically all kinds of equipment. It is not a good arrangement to have motor inspectors and maintenance men do too much construction work as they most often neglect their inspections to do this work. A small construction gang should be employed which can either be put on special work or laid off when the construction work is finished.

G. E. Christoff, Chief Electrician, Marquette Cement Mfg. Co., Cape Girardeau, Mo.: 1. The main duties of the man in charge of maintenance and operation of electrical and associated mechanical systems, may be frequent inspection of the equipment and proper instructions to the men who are under him so that they can give the equipment the best of care.

2. The line of work that would come under the Chief Electrician is all electrical installation, maintenance and overhauling of the electrical equipment. He can best organize a force to handle this work by having a man handle each particular part and see that these men are acquainted with their work. They will then do better work than they would if they were shifted from one job to another. All electrical work can be handled by the Chief Electrician and all mechanical work by the Master Mechanic.

3. The men in charge of maintenance are often requested to change or rearrange some equipment so that it will be possible to obtain greater output or the same amount of output with less expense.

A. W. Durrin, Chief Electrician, Manhasset Mfg. Co., Putnam, Conn.: 1. To provide continuous operation of equipment with the highest possible efficiency at a minimum expense, the lines of work involved are: installation, operation, inspection, repairs and supplies.

The organization of a force to handle this work will naturally vary with the size of the plant and the nature of the product. The organization chart below shows the force required for the electrical and associated mechanical equipment in a works that requires say 5,000 kw. generator capacity. In smaller plants some of these functions would necessarily have to be combined.

The regular inspection of electrical equipment is a most necessary precaution where the utmost in service is required. In a large plant it will be desirable to have men whose special duty it is to regularly (as often as daily in cases of exceptionally sevère service) inspect all equipment and make minor repairs on the job. In medium and small plants, depending also on operating conditions, it can be arranged to have the inspecting done by some of the repair or construction crew.

The number of men required for repair work will, of course, depend on the size of the plant and the operating conditions. To keep repairs at a minimum presupposes a high class of installation work and intelligent and rigid inspection. If there is enough work to justify it, armature and coil-winding equipment are desirable with facilities for baking and testing.

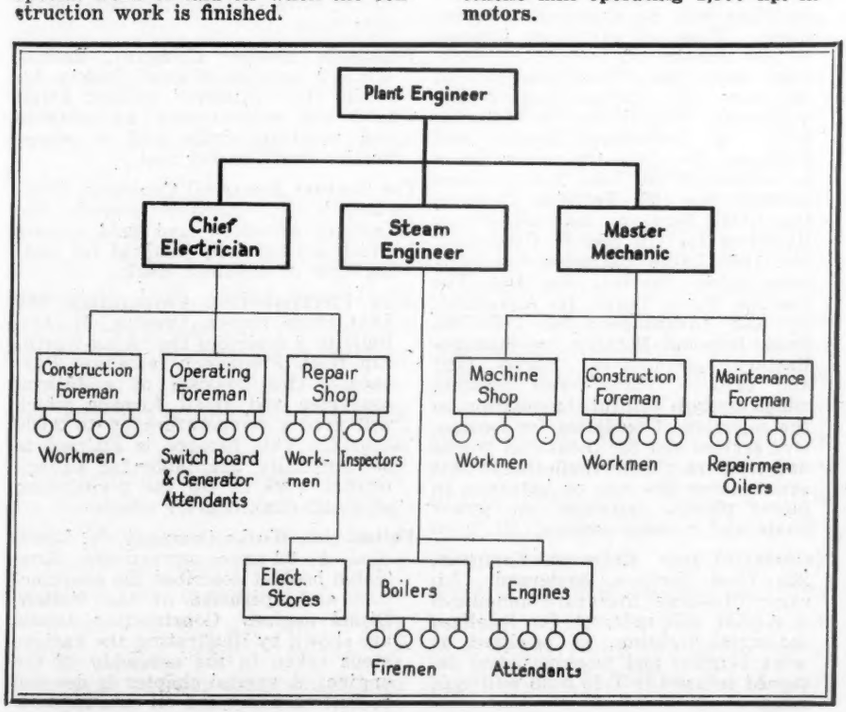
As pointed out in an earlier number of INDUSTRIAL ENGINEER a well-equipped electrical storeroom is a necessity to insure the least possible delay in getting equipment going and keeping it going. On the chart, the electrical stores are put under the repair foreman as in a plant of this size it is convenient to combine the storeroom and repair shop. Of course, the number and size of spare motors, switches and parts to be carried in stock will vary with every plant, but in every case a certain definite amount of spare equipment will prove mighty cheap insurance in keeping things a-running.

As to the work that can best be handled by the Chief Electrician and the Master Mechanic, there is doubtless room for considerable difference of opinion, but the method we have found suitable for the plant here (a textile mill using some 1,800 electrical horsepower) is as follows: The Master Mechanic sets up the machine to be driven, hangs and aligns the motor (all motors here are mounted on the ceiling) which has previously been equipped with the proper size pulleys, puts on the belt and oils the bearings. The Chief Electrician has the conduit, wiring, cut out and switch installed and connects the motor. After the proper direction of rotation is secured that particular machine is ready for production. The oiling of all motors and shafting and the care of all bearings is under the direction of the Master Mechanic. If for any reason a motor has to be taken down the fuses are pulled and the motor disconnected by the electrician, while the mechanic lowers the motor to the floor. The Chief Electrician, of course, has charge of inspecting all electrical equipment and cleaning of motors and switches, which is done periodically.

3. A maintenance organization should show the greatest saving on repair work, particularly that which involves the stoppage of work in process. A rigid inspection system, and a well-equipped storeroom backed up by a capable body of workmen can effect very great savings by reducing the delays and losses due to failure of electrical equipment to a minimum.

4. Probably this will vary greatly in different plants. Here we are frequently called upon to change from group drive to individual drive; also to install additional feeders to relieve those that are overloaded or becoming so. It is also a common occurrence to change the lighting layout to suit changed operating conditions. Much valuable information along this line has appeared in INDUSTRIAL ENGINEER.

Maintenance organization for a textile mill operating 1,800 hp. in motors.



Reclamation Plant for Equipment

(Continued from page 46)

sold. Other brass scrap is carefully classified according to the various grades and sold. The insulation is burned from copper wire and cable which is not otherwise usable, and the wire sold as scrap copper. Burned-out incandescent lamps with unbroken bulbs are often sold to lamp manufacturers. Glass, comprising broken window panes, bottles, incandescent lamp bulbs and so on is collected and sold to glass makers. The brass base of broken lamps is sold as brass scrap. Waste paper is sorted, baled and sold to dealers in this material. Burlap, felt and so on are likewise sorted and baled.

As was mentioned previously, iron and steel scrap is sorted in the yard, classified as cast or malleable iron, low-carbon steel, tool steel, and so on and disposed of to junk dealers.

After the material which comes to us has been worked over as described above and either put again into usable form or prepared for sale as scrap, there remains the problem of disposing of it, as we do not attempt to store any large quantity of supplies. This distribution is handled in the following manner: Once a month the purchasing department sends us a list of the materials and supplies which have been requisitioned by the various storehouses and other departments of the road. Items which we can supply from our stock are taken off this list. Requisitions are then issued on us by the department or storehouse which needs the material and we send it on, charging it against the department at the prevailing market price.

Scrap material is, of course, sold to junk dealers, on the highest bid.

The growth of the Corwith plant has been gradual but steady. At first only a comparatively few items of equipment and material were salvaged, but as market conditions have changed and our experience has grown we have increased the extent of our work. There are still many items which we do not attempt to reclaim, although the number is reduced from time to time. With the wide variety of material which comes to us it is sometimes difficult to decide just what should be done with a particular item. In practically all cases the answer to the question, "Can it be reclaimed at a profit?" is the deciding factor.

Trade Literature *You Should Know About*

Copies of literature which is described on this page can be obtained by writing to the manufacturer whose name and address are mentioned. It is always advisable to state the name and number of the bulletin or catalog desired, as given in these columns.

Smith and Serrell, Central Avenue at Halsey Street, Newark, N. J.—A new 32-page bulletin, 37, describes the line of "Franke Flexible Couplings for Direct-Connected Machines." This not only contains a large number of photographs of machines, in various industries, which are direct-connected by flexible couplings, but also a number of special machines which often use this equipment. In addition to descriptions of the application of the various types, a page of directions for selecting the proper size is included, as well as directions for installing the couplings and information for the user. Three pages are given over to information about direct-connected installations which show how to install, grout, align, and check up the coupling.

Foamite-Childs Corporation, Utica, N. Y.—A 16-page booklet entitled, "The Essentials of Self-Protection Against Fire," discusses the various types of portable fire extinguishers and their use on the different classes of fires. For easy reference this information is charted.

The Electric Storage Battery Company, Alleghany Avenue and Nineteenth Street, Philadelphia, Pa.—Eighteen bulletins which comprise a complete storage battery engineering and operating data book have been gathered into a spring back binder which will be distributed to electrical engineers requesting it on their official stationery. Copies of individual bulletins will be supplied upon request. Those of particular interest to the readers of INDUSTRIAL ENGINEER are: No. 159—Exide-Ironclad Batteries for Storage-Battery Locomotives; No. 160R—The Adaptability of Industrial Trucks and Tractors; No. 181—Operating Characteristics of the Lead Acid Storage Battery; No. 188—Portable Types of the Exide Battery; No. 191—Exide Batteries for Oil Switch Operation; No. 192—Exide Batteries for Portable Signal Service; No. 194—The Electric Motor Truck, Its Adaptability and Advantages; No. 195—The Exide-Ironclad Battery for Storage-Battery Locomotives; Forms 1791 and 1874 — "Facts"—two booklets which contain helpful information on the selection of batteries for locomotive service and for industrial trucks and tractors. Other bulletins in this series cover the use of batteries in power plants, railways, on power boats and in other service.

National X-Ray Reflector Company, 235 West Jackson Boulevard, Chicago, Ill.—New literature announces a special mill reflector for localized industrial lighting, as required on work benches and machines, and designed to use the T-19 bulb mill-type lamp.

The Esterline Company, Indianapolis, Ind.—An attractive 48-page booklet entitled "Do It Graphically," sets forth the advantages of graphic records as obtained through the use of Esterline graphic instruments. Some of the points discussed are: Graphic records and the executive; increasing the productiveness of labor; graphics for measurement of power; testing and recording the performance of equipment; obtaining data for design. A complete description of the mechanical and electrical elements of the meters, as well as their construction and operation is included.

Edwin L. Wiegand Company, 422 First Avenue, Pittsburgh, Pa.—Folders describe the "Chromalox" strip heaters for commercial and domestic heating. These strip heaters are used in elevators, baking and drying ovens, and for other industrial purposes.

Reliance Electric and Engineering Company, Cleveland, Ohio—Bulletin 1014 describes the Reliance Type AS adjustable speed motors of the armature shifting design for direct current. Considerable space is given to a discussion of the mechanical details and principles of operation, starting and reversing equipment, speed control, and the characteristic curves. A table of ratings and dimensions as well as a number of illustrations of actual installations are included.

Graver Corporation, East Chicago, Ind.—Bulletin 501 covers the Graver Water Filters of the horizontal pressure type.

Wisconsin Electric Company, Racine, Wis.—A number of small folders describe the "Dumore" electric small tools and motors such as portable and precision drills and a geared flexible-shaft, utility tool.

The Century Electrical Company, Syracuse, N. Y.—Circulars describe the Century armature and field testers which are specially adapted for testing new or repaired work.

Ajax Electrothermic Corporation, 636 East State Street, Trenton, N. J.—Bulletin 2 describes the "Ajax-Northrup High Frequency Induction Furnace." This consists of a 15-kva. converter and small furnace which will give a temperature up to 2,000 deg. C. This furnace is claimed to be especially adaptable for experimental work or for the preparation of small quantities of alloys.

Fulton Iron Works Company, St. Louis, Mo.—A 32-page attractively illustrated booklet describes the construction and operation of the Fulton-Diesel engine. Construction details are shown by illustrating the various steps taken in the assembly of the engine. A special chapter is devoted to fuel economy and oil consumption.